11 kW bi-directional CLLC DC-DC converter with 1200 V and 1700 V CoolSiC™ MOSFETs

About this document

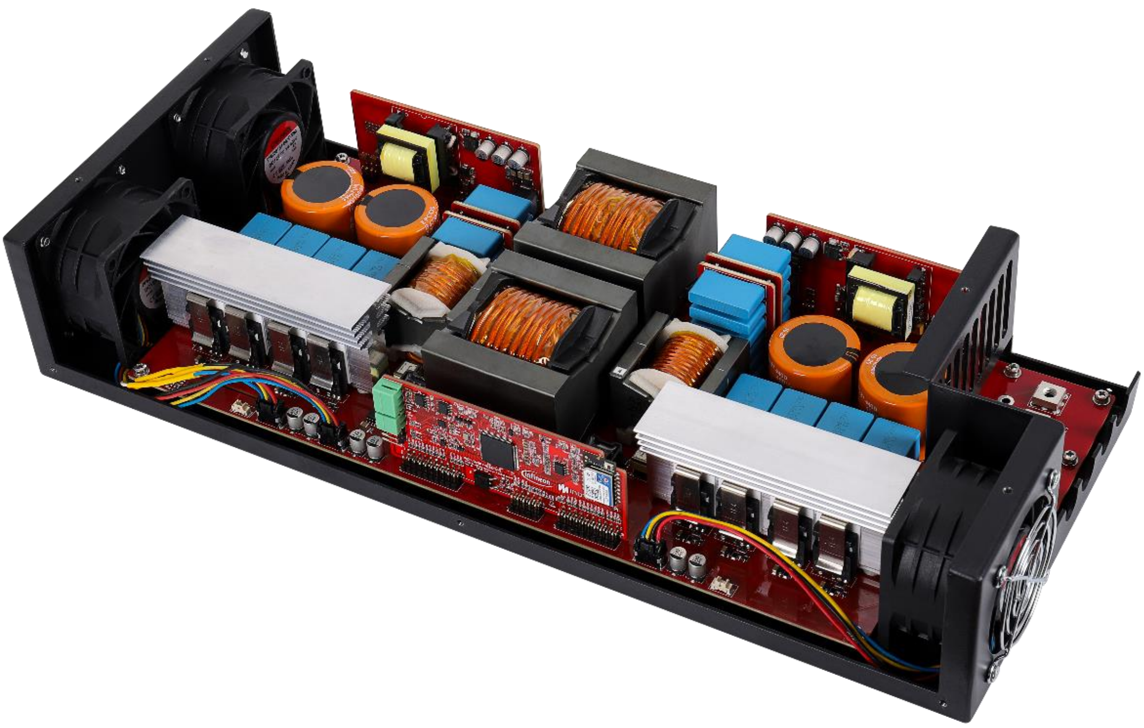
Scope and purpose

This document introduces a complete Infineon Technologies AG system solution for an 11 kW bi-directional DC-DC converter. The REF-DAB11KIZSICSYS board is a DC-DC stage with a wide range output using two inductors and two capacitors (CLLC) resonant network with bi-directional capability. This converter can operate under high power conversion efficiency, as the symmetric CLLC resonant network has zero-voltage switching capability for primary power switches and synchronous-rectification commutation capability for secondary-side output rectifiers. The converter could change the power flow direction, and its maximum power conversion efficiency was around 97.2% during the operation without synchronous-rectification.

This document shows the board using 1200 V CoolSiC™ MOSFETs in TO247-4 package and EiceDRIVER™ 1ED compact gate driver ICs, which leverage the advantages of SiC technology including improved efficiency, space and weight savings, part count reduction, and enhanced system reliability.

Intended audience

This document is intended for engineers who want to use 1200 V and 1700 V CoolSiC™ MOSFETs with EiceDRIVER™ driver ICs for bi-directional resonant topology applications such as EV-charger wall box, energy storage systems to achieve reliable main-circuit design and increased power density.



Reference board/kit

Product(s) embedded in a PCB, with focus on specific applications and defined use cases that can include software. PCB and auxiliary circuits are optimized for the requirements of the target application.

Note: Boards do not necessarily meet safety, EMI, quality standards (for example UL, CE) requirements.

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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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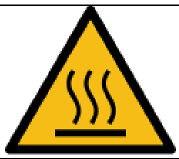
Safety precautions

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 V_{DC}. 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.*

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1 The board at a glance

E-mobility is well on its way to revolutionizing private and public transportation, reducing air pollution and making the earth a better place to live. Energy storage systems can also help save energy consumption by maximizing the allocation of energy.

Infineon is proud to be a key player in this green megatrend. Being a one-stop shop for high-quality components and solutions, the target of the REF-DAB11KIZSICSYS board is to build up a solution for bi-directional DC-DC converters, which will enable customers to implement unique bi-directional charger designs in a very short time. This featured 11 kW CLLC resonant DC-DC converter with bi-directional power flow capability and soft-switching characteristics is the ideal choice for on- & off-board chargers and energy storage systems (ESS). This reference design provides a complete and fully characterized hardware and firmware solution, and user-friendly graphical user interface (GUI). It ensures that CoolSiC™ MOSFETs integrate with Infineon driver IC, XMC controller, flyback controller, voltage regulator MOSFETs, current sensor, Cypress memory, and security & safety chip. It is the perfect way to improve cost-effective power density with high reliability, and easy usage up to the next level!

In UG-2020-31, Figure 1 shows the placement of the different main components on the 11 kW bi-directional DC-DC converter. The outer dimensions of the board, enclosed in the case, are 360 mm x 160 mm x 65 mm, which results in a power density in the range of 3 W/cm^3 (5.5 W/g).

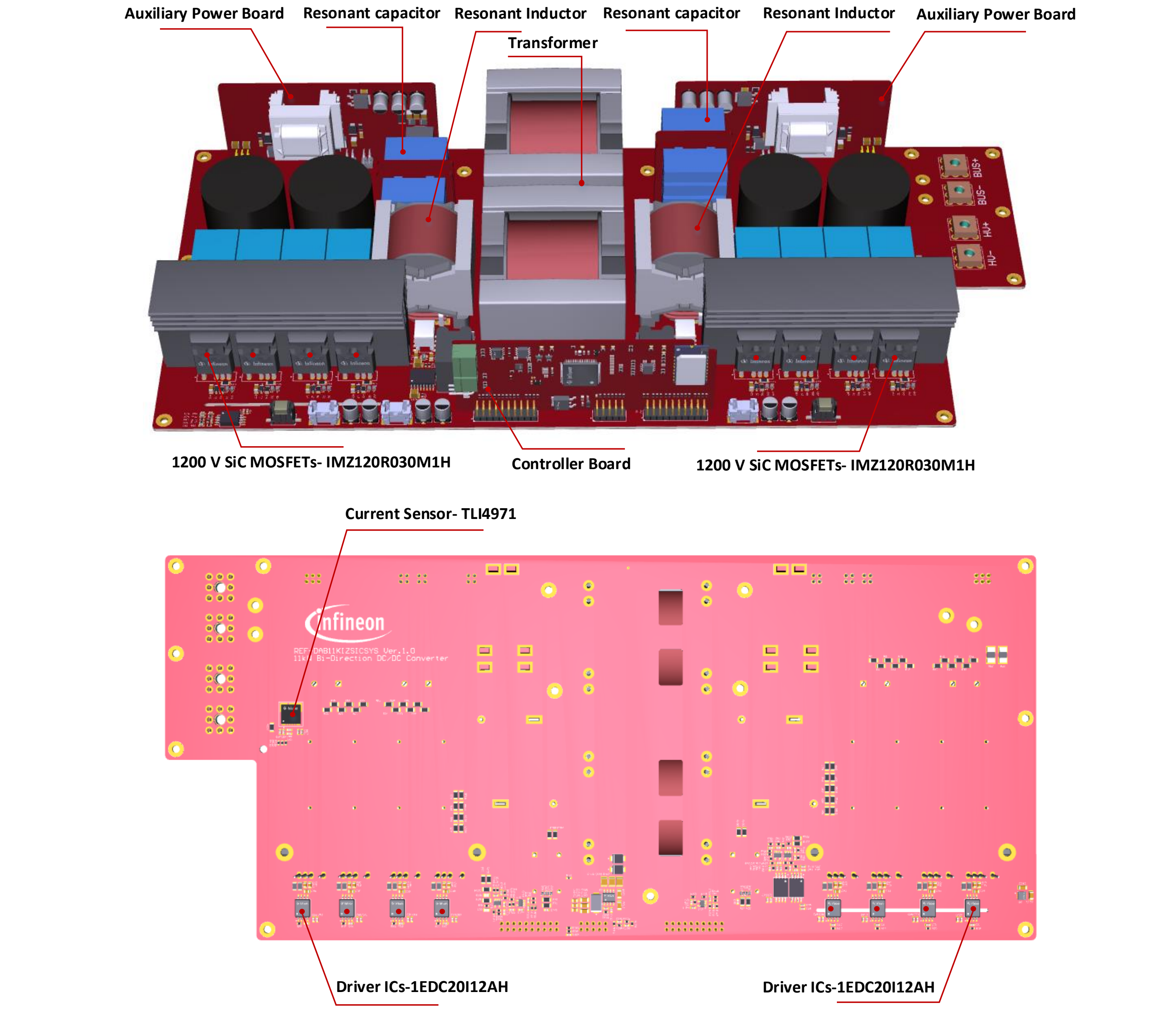

Figure 1 Placement of the different sections in the 11 kW bi-directional CLLC DC-DC converter with Infineon CoolSiC™ MOSFETs.

1.1 Delivery content

The 11 kW bi-directional board is a CLLC DC-DC converter developed with Infineon power semiconductors as well as Infineon drivers, current sensor, controllers, communication chip, security chip and memory chip. The combination of these devices can provide customers with an optimized system solution. The Infineon devices used in the implementation of the 11 kW bi-directional board include:

Main power board

- 1200 V CoolSiC™ MOSFETs discrete - IMZ120R030M1H
- 1200VSingle channel IGBT gate driver IC in wide body package -1EDC20I12AH
- XENSIV™ - high-precision coreless current sensors for industrial applications- TLI4971

Auxiliary power board

- 1700 V CoolSiC™ MOSFET discrete- IMBF170R1K0M1
- PWM-QR (quasi resonant) flyback control ICs- ICE5QSAG
- 10A Synchronous DC/DC Step-Down Controller-IFX81481ELV
- OptiMOS™ 5 Power-Transistor-BSZ068N06NS

Controller board

- 32-bit XMC4000 industrial microcontroller ARM® Cortex®-M4 family- XMC4400-F100k512 BA
- High speed CAN transceiver generation-TLE9251VSJ
- OPTIGA™ TRUST M -SLS32AIA
- Low voltage drop linear voltage regulators - IFX25001TFV33
- 256-Kbit (32K × 8) serial (SPI) F-RAM: FM25V02A from Cypress

More information concerning these devices is available on Infineon website.

1.2 Block diagram

The REF-DAB11KIZSICSYS design consists of a CLLC in full-bridge configuration (Figure 2). The CLLC resonant converter is widely used as a DC transformer to interlink the AC/DC to DC bus, because of its advantages of high power density and the capacity of bi-directional power transfer. In both forward and reverse modes, the resonant tank possesses almost the same operational characteristics of the conventional LLC resonant tank. Thus the ZVS+ZCS soft switching can be achieved both in forward and reverse modes, and the switching losses can be minimized, thereby improving charger efficiency.

This architecture showed in the block diagram contains three parts, the main power circuit, the auxiliary power board and the control board.

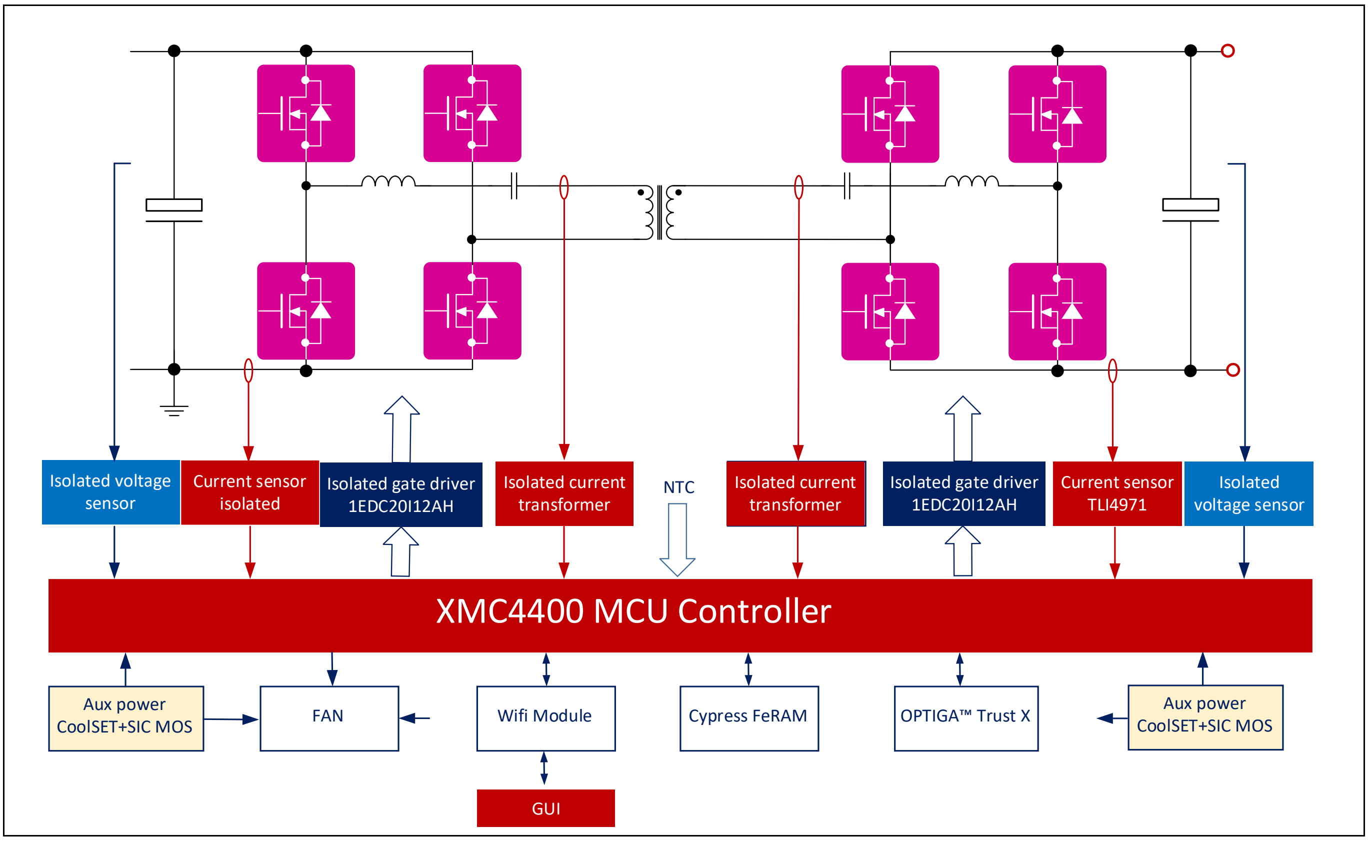

Figure 2 11 kW bi-directional CLLC DC-DC converter (REF-DAB11KIZSICSYS) – simplified diagram showing the Infineon semiconductors used in the system

The main power circuit includes 1200 V CoolSiC™ MOSFETs make high efficiency possible.

The auxiliary power supply uses 1700 V CoolSiC™ MOSFETs for an efficient design, as it is as small as a card.

The control is implemented in an XMC4400 Infineon microcontroller, which includes the following features:

- ARM® Cortex™-M4, 120MHz, incl. single cycle DSP MAC and floating point unit (FPU)
- 8-channel DMA + dedicated DMAs for USB and Ethernet
- USIC 4ch [Quad SPI, SCI/UART, I^2C, I^2S, LIN]
- Supply voltage range: 3.13 - 3.63V
- USB 2.0 full-speed, on-the-go
- CPU frequency: 120MHz
- Peripherals‘ clock: 120 [MHZ]
- eFlash: 512 kB including hardware ECC
- 80 kB SRAM
- 10/100 Ethernet MAC (/w IEEE 1588)
- 2x CAN, 64 MO
- Package: PG-LQFP-100
- 4x ΔΣ demodulator
- Temperature range from -40° to 125°

Further details about the digital control implementation and other functionalities of CLLC in the XMC™ 4000 family can be found on the Infineon website.

1.3 Main features

A bi-directional full-bridge CLLC resonant converter using a symmetric CLLC-type resonant network is proposed for a bi-directional power distribution system. This converter can operate under high power conversion efficiency, as the symmetric LLC resonant network has zero-voltage switching capability for primary power switches and synchronous rectification capability for secondary- side rectifiers.

In addition, the proposed topology does not require any snubber circuits to reduce the voltage stress of the switching devices because the switch voltage of the primary and secondary power stage is confined by the input and output voltage, respectively. In addition, the power conversion efficiency of any direction is similar. Intelligent digital-control algorithms are also proposed to regulate output voltage, control bi-directional power conversions and to achieve synchronous rectification.

1.4 Board parameters and technical data

Table 2 shows the specifications of the board

Table 2 Parameter

Parameter	Symbol	Conditions	Value	Unit
Rated power	P	V_{bus}=750V, V_{HV}=800V,Ta=25^{0}C. $I_{pri.}$=15A	11	KW
Primary side bus voltage	V_{bus}	-	750	V
Secondary side bus voltage	V_{HV}	-	550-~800	V
Primary side current	$I_{pri.}$	V_{bus}=750V, V_{HV}=800V,Ta=25^{0}C. $I_{pri.}$=15A	15	A
Secondary side current	$I_{sec.}$	V_{HV}=550V,P=11KW, Ta=25^{0}C.	20	A
Switching frequency	f_s	-	40~250	Khz
Auxiliary power output voltage	$V_{aux.}$	$P_{aux.}$=32W	20	V
Auxiliary power output power	$P_{aux.}$	$V_{aux.}$=20V, Ta=25^{0}C.	32	W
Board net weight	W	Without encloser	2	Kg

2 System and functional description

2.1 Commissioning

This chapter presents the set-up on how to evaluate the performance and behavior of the 11 kW bi-directional DC-DC converter using CoolSiC™ MOSFETs.

- DC source provides the power to the converter prototype
- Secondary side of converter prototype connect with the DC electric load
- The host computer controls the start and stop of the prototype and sets the working parameters through GUI
- Observe the corresponding waveforms with an oscilloscope

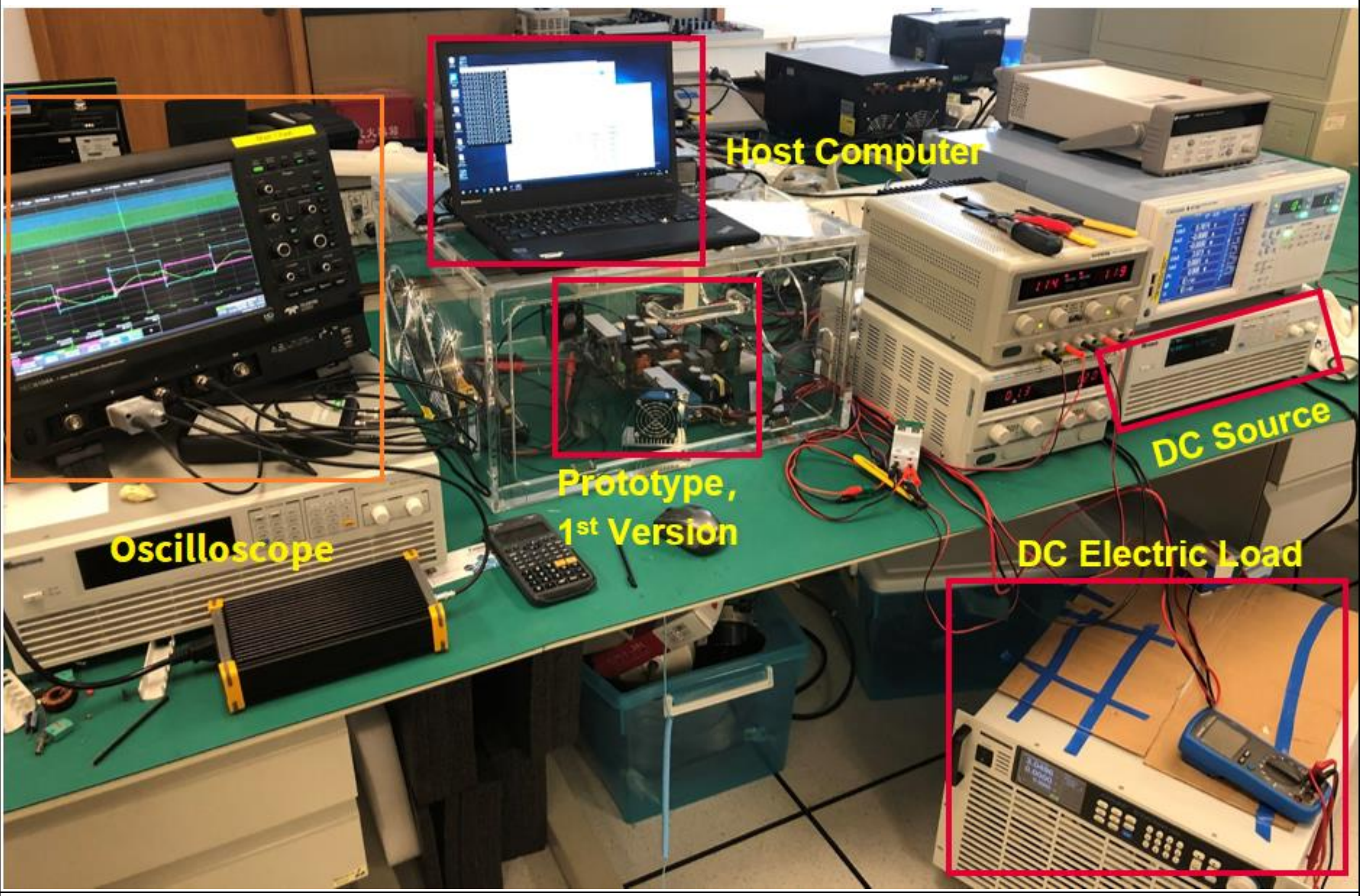

Figure 3 11 kW bi-directional CLLC DC-DC converter measuring environment

2.2 Description of the functional blocks

The 11 kW bi-directional CLLC DC-DC converter can operate as an isolated buck or as an isolated boost converter, with the power flowing from the bus side to the isolated HV side or vice versa.

For validation of the buck mode, the suggested set-up includes:

• Bus supply capable of 700 V~800 V and at least 11 kW (when testing up to full load)

• HV electronic load (500 V to 800 V), in constant current mode, capable of at least 11 kW (when testing up to full load). Nominal input voltage of the converter is 750 V. The converter works as indicated in Figure 4.

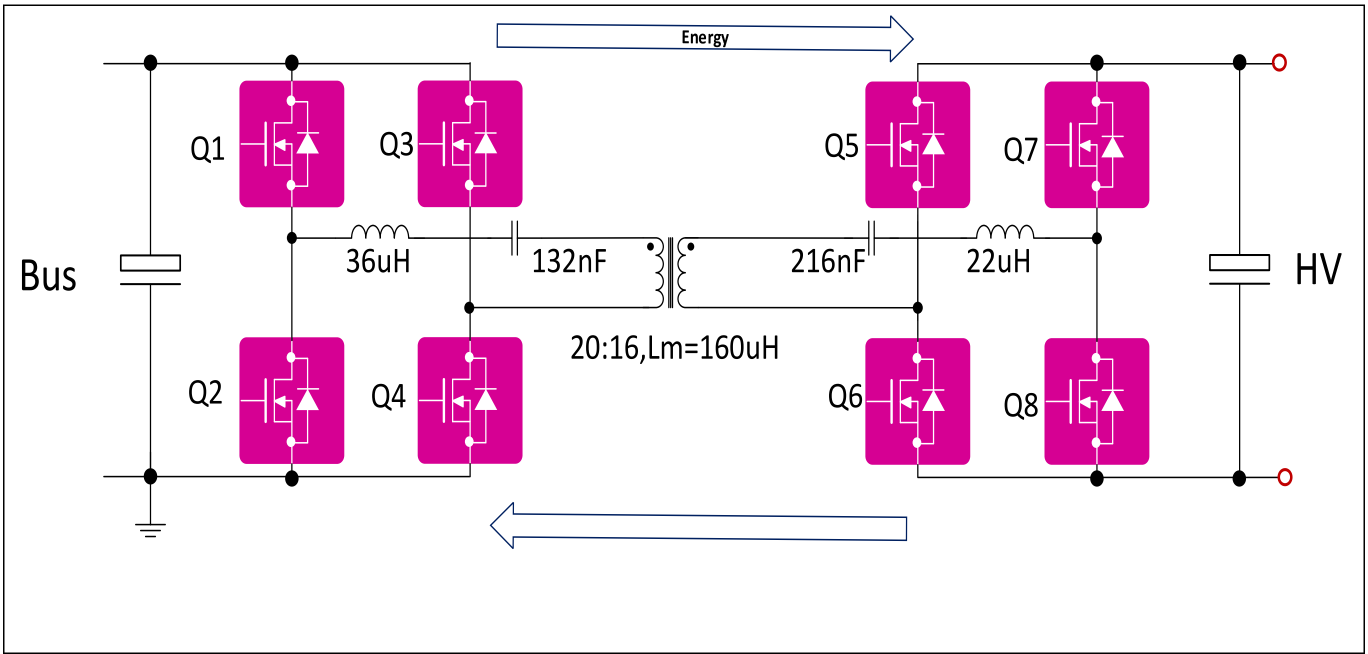

Figure 4 Buck mode recommended validation set-up

For validation of the boost mode, the suggested set-up is exactly the same as for the buck mode, except for thing: the output voltage parameter must be changed in the GUI window.

2.2.1 Description of the functional blocks

The output gain function of CLLC topology is generally analyzed by the fundamental wave-analysis method. Based on this analysis method, the parameters of the key resonant components in the current design are shown in the Figure 4:

By using this parameter, the resonance parameter Q of the primary and secondary transformers is consistent, and the natural resonance frequency is 73 kHz. In the design, we chose a switching frequency of the topology in the range of 40 kHz to 250 KHz.

The structure of CLLC topology on the primary side and the secondary side is the same. On the contrary, the fundamental wave-analysis method is also valid.

The current of the primary/secondary resonant cavity and the V_{ds} waveform of the SiC MOSFET in the steady state can be obtained as follows with the help of PLECS simulation software for verification:

Buck mode (forward-energy transmission), input voltage 800 V, and output voltage 550 V with load 27.5 Ω. At this time, the CLLC topology switching frequency is 86.2 KHz:

Ilr_pri is the primary side resonant tank current.

Ilr_sec is the secondary side resonant tank current.

VHB is the V_{ds} voltage of Q2 (The position of SiC MOSFETs Q1~Q8 can be seen in Figure 4.).

Fsw is the switching frequency.

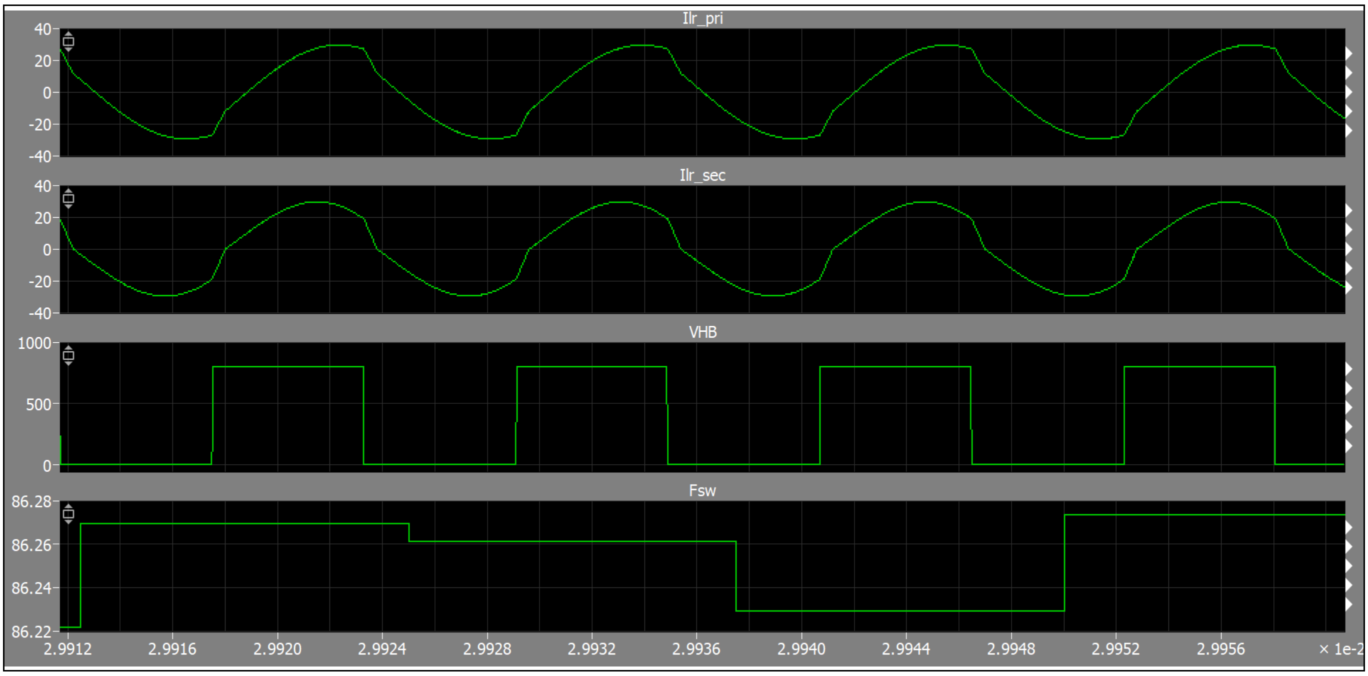

Figure 5 Simulation result of CLLC buck mode

Forward-energy transmission, input voltage 750 V, output voltage 750 V, load 51.1 Ohm. The switching frequency of CLLC topology is 54.0 KHz at this condition, the simulation waveform can be seen in Figure 6.

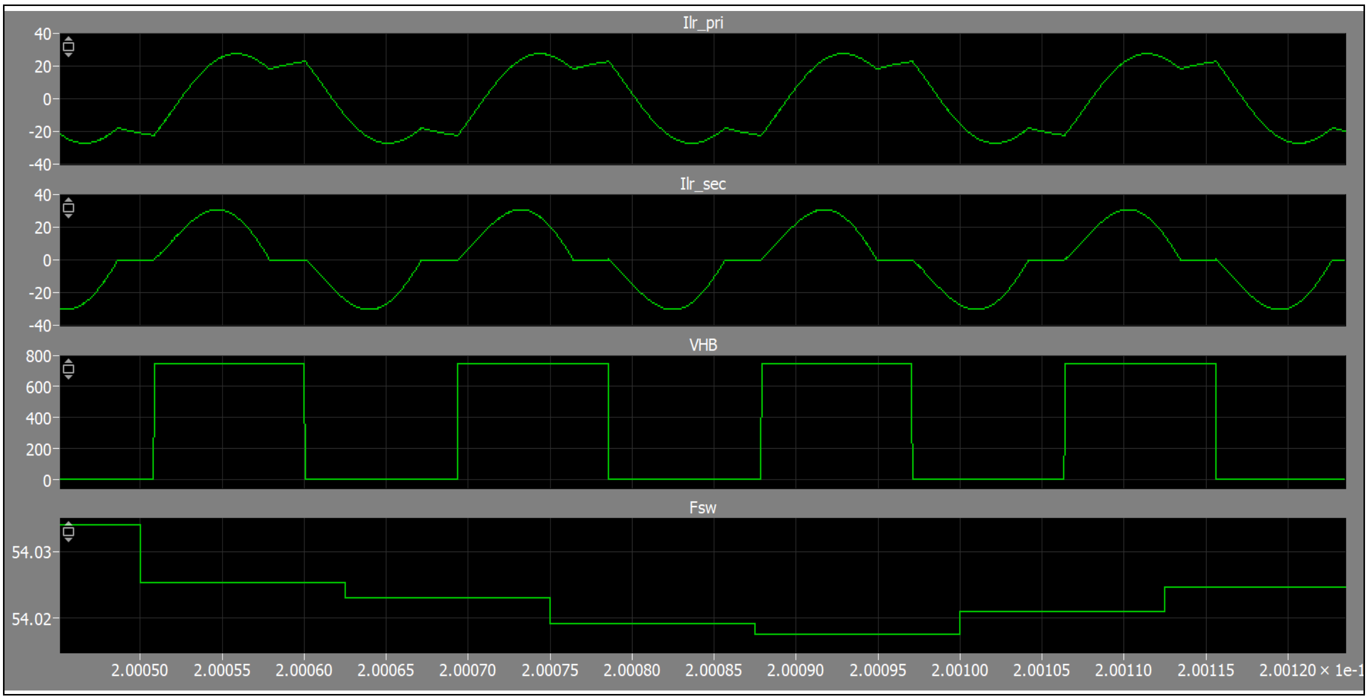

Figure 6 Simulation result of CLLC

Boost mode (forward-energy transmission), input voltage 700 V, output voltage 800 V, load 58.1 Ohm. At this time, the CLLC topology switching frequency is around 48.2 KHz:

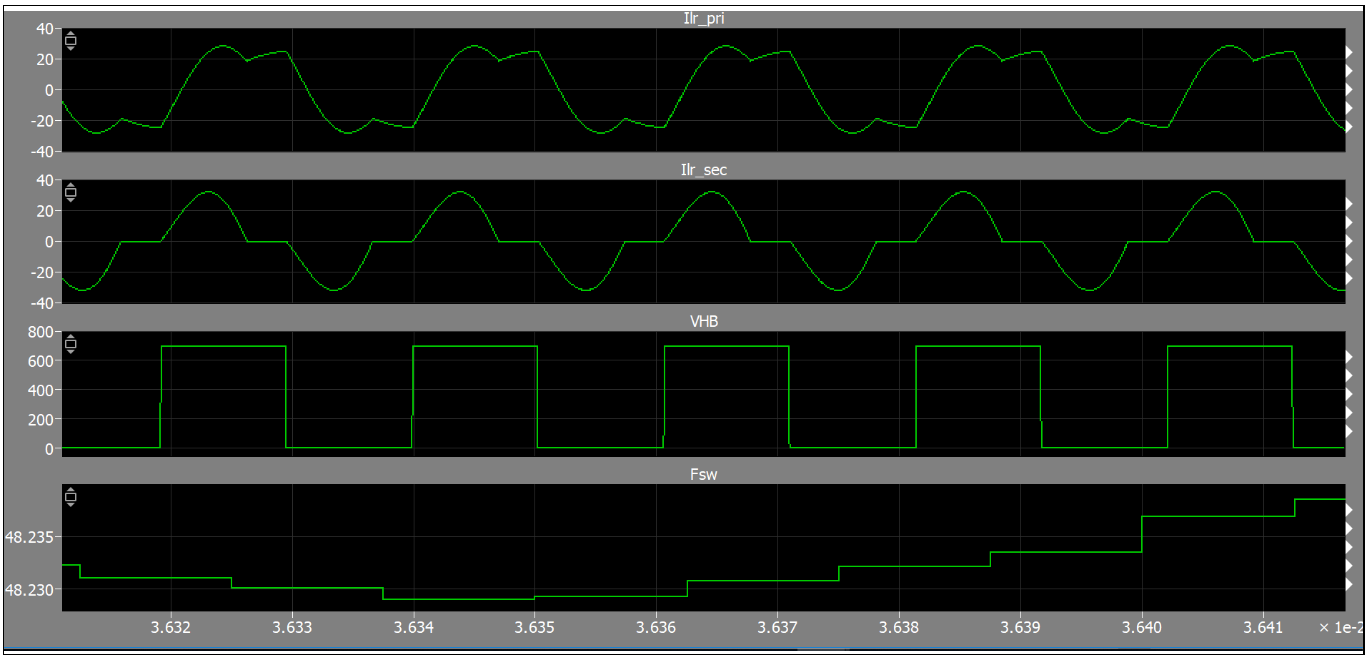

Figure 7 Simulation result of CLLC boost mode

In the case of no load or light load, the CLLC topology must work in frequency-modulation mode (PFM), otherwise the power devices in the circuit may work at a very high switching frequency. Due to the existence of parasitic parameters, the output voltage cannot be reduced to the target value under the circumstances of continuous wave mode. The topology will work in this mode:

Channel 1 is the controller board output pulse-width modulation (PWM) signal.

Channel 2 is the output voltage.

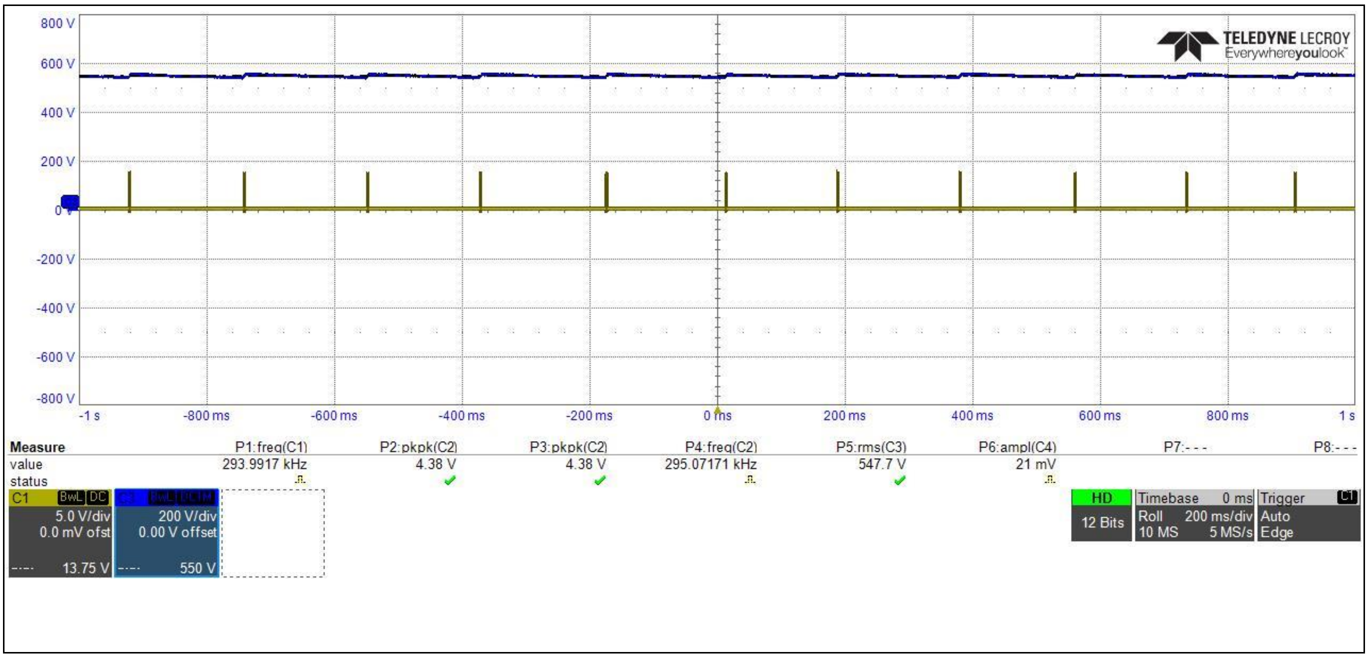

Figure 8 Test result of light load

In the "burst" state, the output voltage waveform is as follows when a sudden load is added:

Channel 3 is the output voltage.

Channel 4 is the load current.

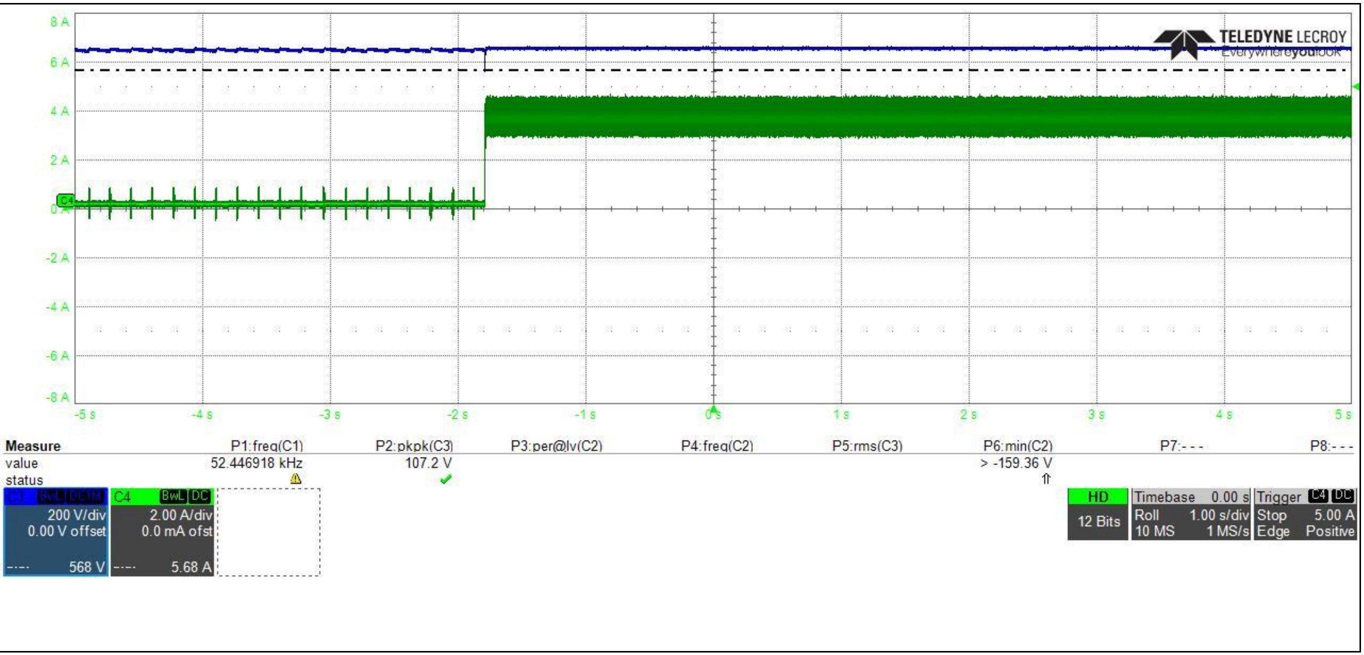

Figure 9 **Test result of added sudden load**

At this time, there is an obvious overshoot of resonant cavity current according to Figure 10. If the peak value is more than 40 A, it will trigger the overcurrent protection:

Channel 2 is the gate PWM signal of Q2.

Channel 3 is the V_{ds} voltage of Q2.

Channel 4 is the primary side resonant tank current.

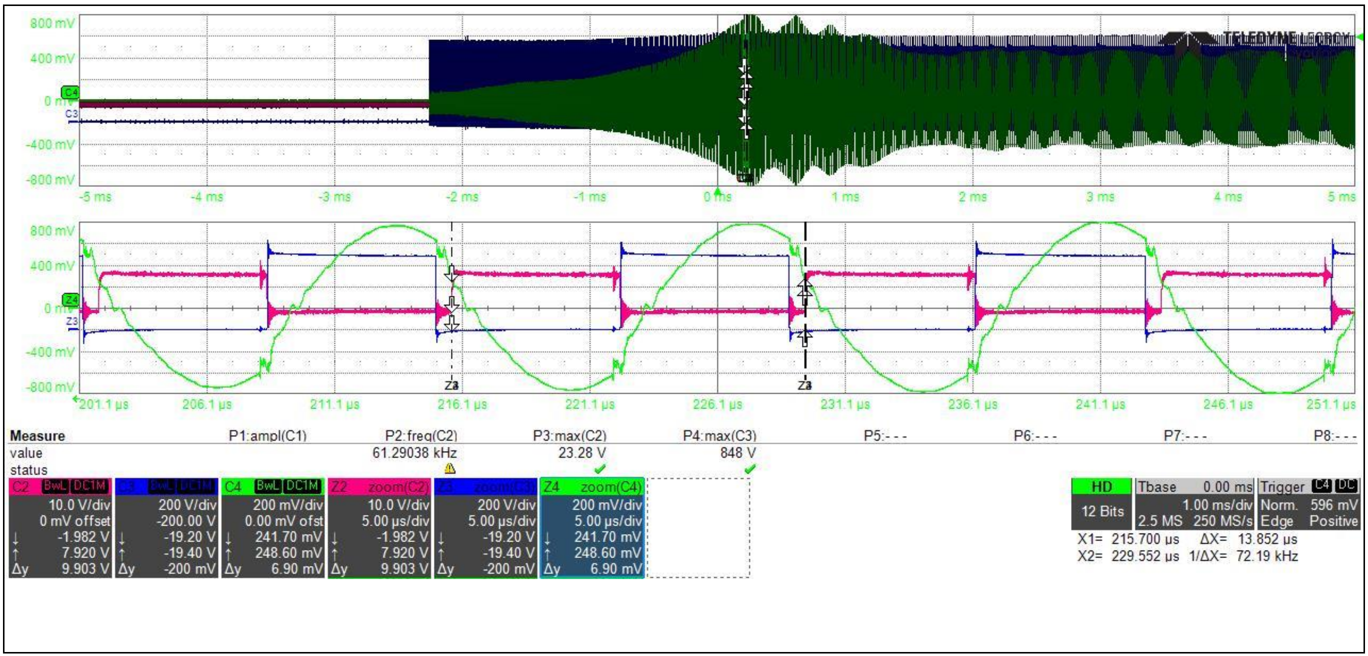

Figure 10 **Test result of added sudden load**

Steady state, the V_{gs}/V_{ds} voltage waveform of SiC MOSFET and current waveform in the resonation tank can be seen in Figure 11.

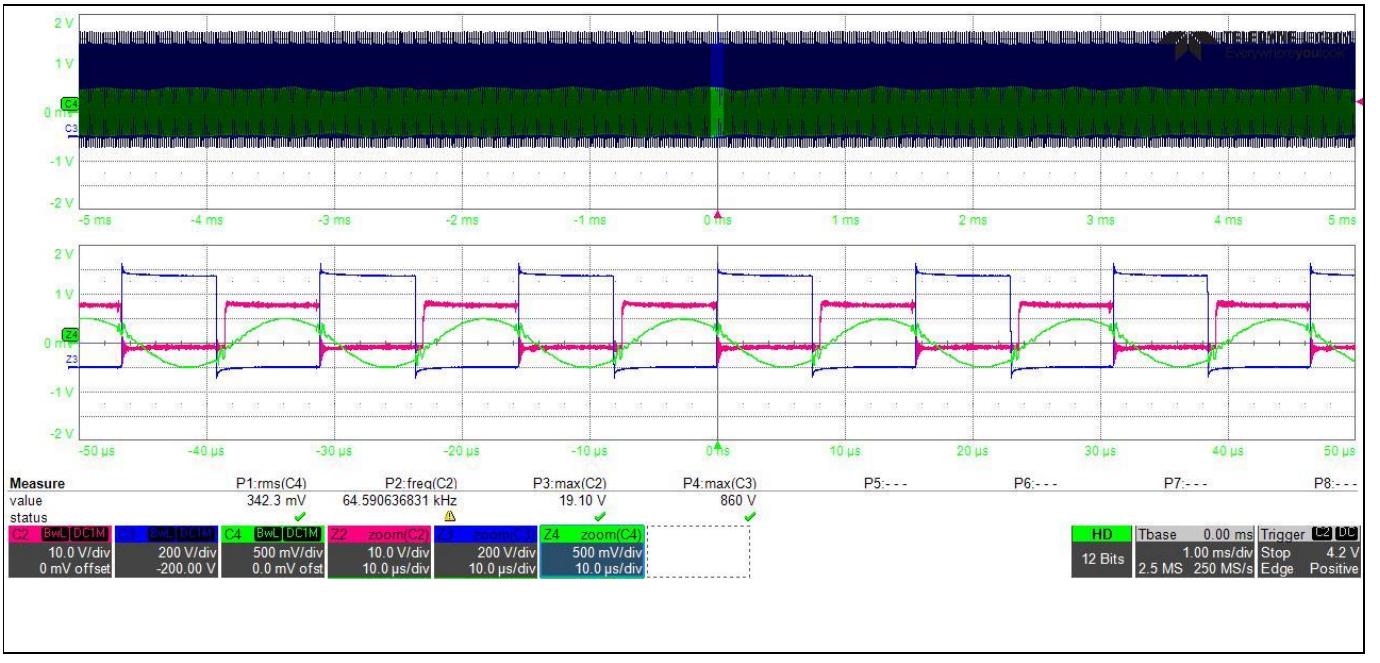

Figure 11 Test waveform when the load is 10KW

For more expanded waveform details, please see Figure 12 below.

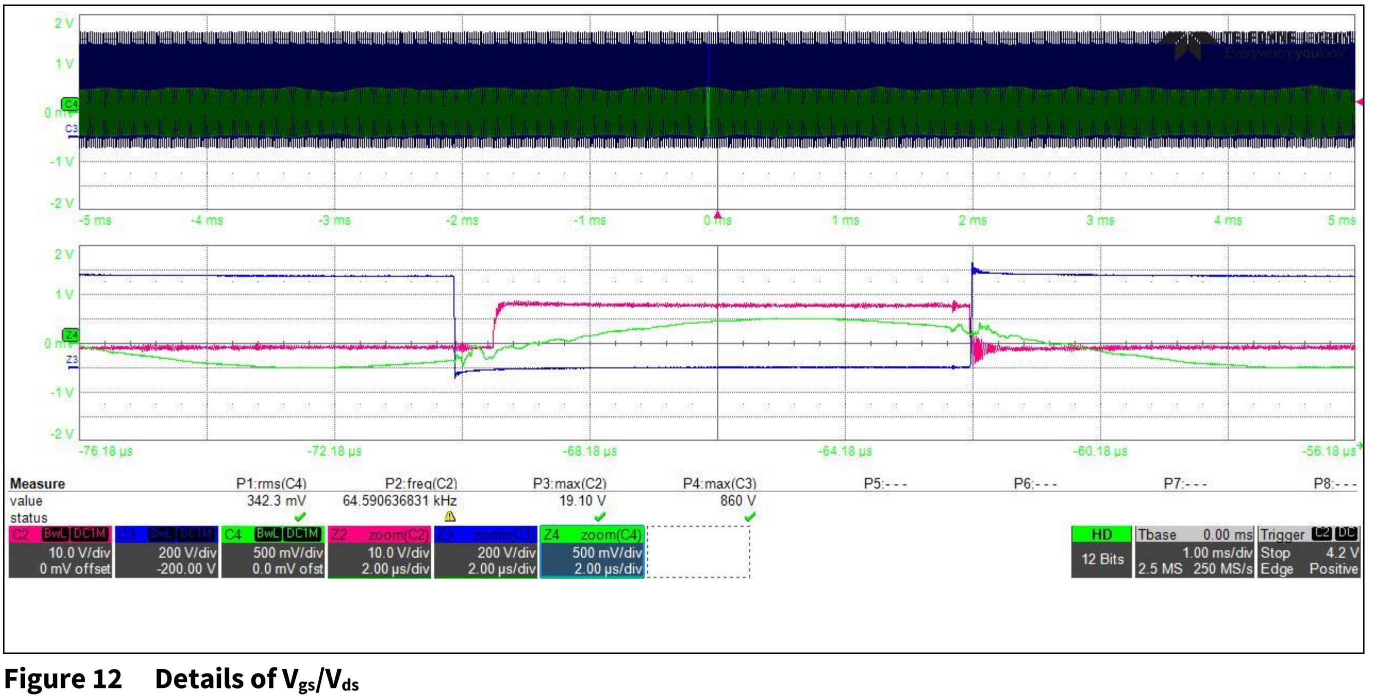

Figure 12 Details of V_{gs}/V_{ds}

In Figure 13, the output voltage ripple is around 16.5 V; here we have considered the peak-to-peak value.

Channel 1 is the controller output PWM signal.

Channel 2 is the output voltage, here we consider the peak-to-peak value.

Figure 13 Output voltage ripple

2.2.2 Special operation modes

The CLLC circuit used CoolSiC™ MOSFETs in the primary and secondary sides, so under normal work conditions when one side of the transformer is in the switching state, the other side works in the diode rectification mode. As known, MOSFET body diodes have considerable conduction voltage drops. Fortunately, the channel of the MOSFET has reverse-conduction capability with a much smaller conducting voltage drop than its body diode. Therefore it is necessary to adopt the synchronous rectification method to reduce the conduction loss on the rectifier side, and improve the conversion efficiency.

Here explain a basic principle of the synchronous rectification scheme:

Under normal circumstances, dedicated synchronous rectifier drive controllers are widely used to detect the V_{ds} of the rectifier tube, and to control the gate drive in time. However, we cannot use this method in bi-directional

DC/DC converters. In this board, we adopted another low-cost method to achieve synchronous rectification control:

- By sampling the current on the secondary side of the transformer through the current transformer CT, and converting the periodic positive and negative current sampling signal into a DC current via the rectifier circuit, then sending it to the non-inverting input of the comparator;
- The comparator compares the rectified current sampling signal with a fixed threshold V_{ref}, which is set to be slightly more than 0;
- The output inversion signal of the comparator and the primary pulse-width modulation (PWM) signal are subjected to the AND operation and then sent to the corresponding rectifier drive circuit as the drive signal. This process can also be completed by the MCU.

Below is the implementation block diagram of the synchronous rectification function:

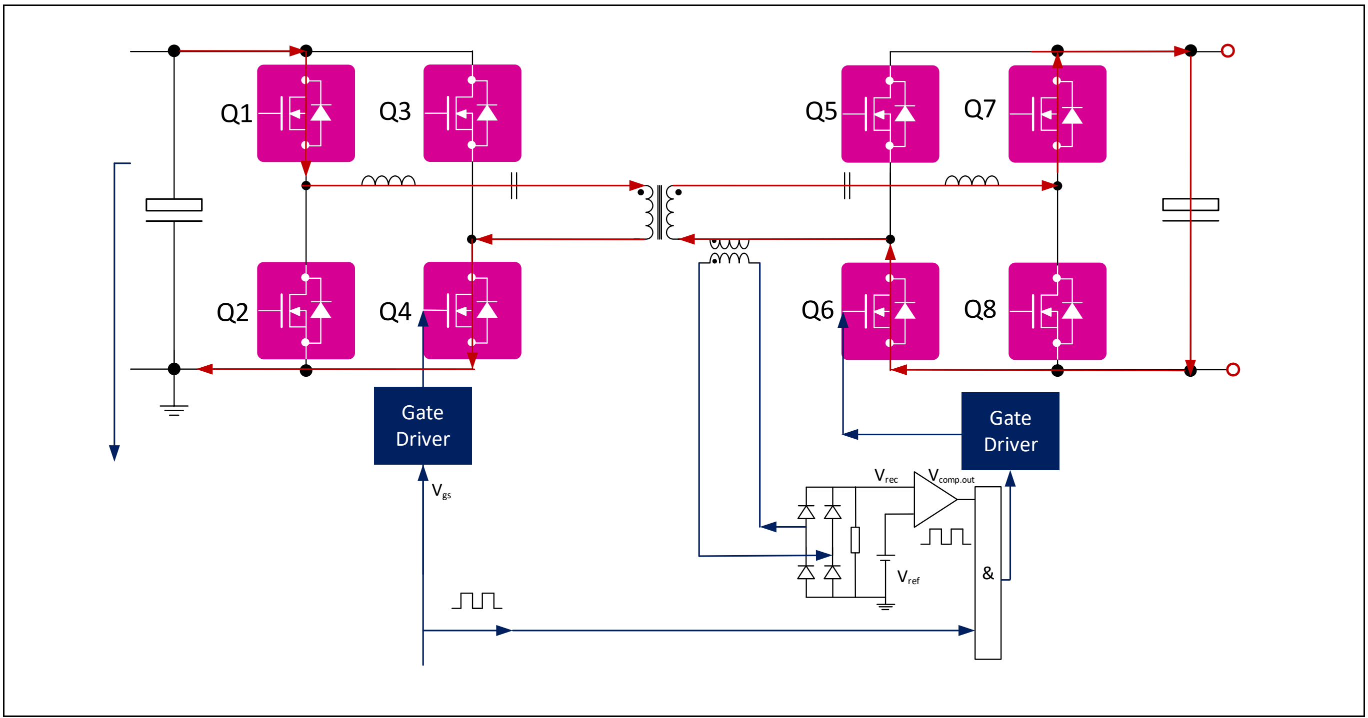

Figure 14 Synchronous rectification function

With this method, it is easy to achieve synchronous rectification. At present, the AND operation between the flip signal output by the comparator and the primary PWM signal is carried out inside the MCU. The MCU recognizes that the comparator outputs a high level, and triggers an external interrupt, which is combined with the current cycle of the PWM wave-sending sequence in the interrupt service routine. The corresponding synchronous rectification drive is issued, but there is a certain delay in the actual measurement software processing. The actual measurement current delay is about 1 µs, and software optimization is required to reduce this delay time.

Channel 1 is the V_{ref}.

Channel 2 is output signal of the comparator.

Channel 3 is secondary side gate PWM signal.

Channel 4 is primary side gate PWM signal.

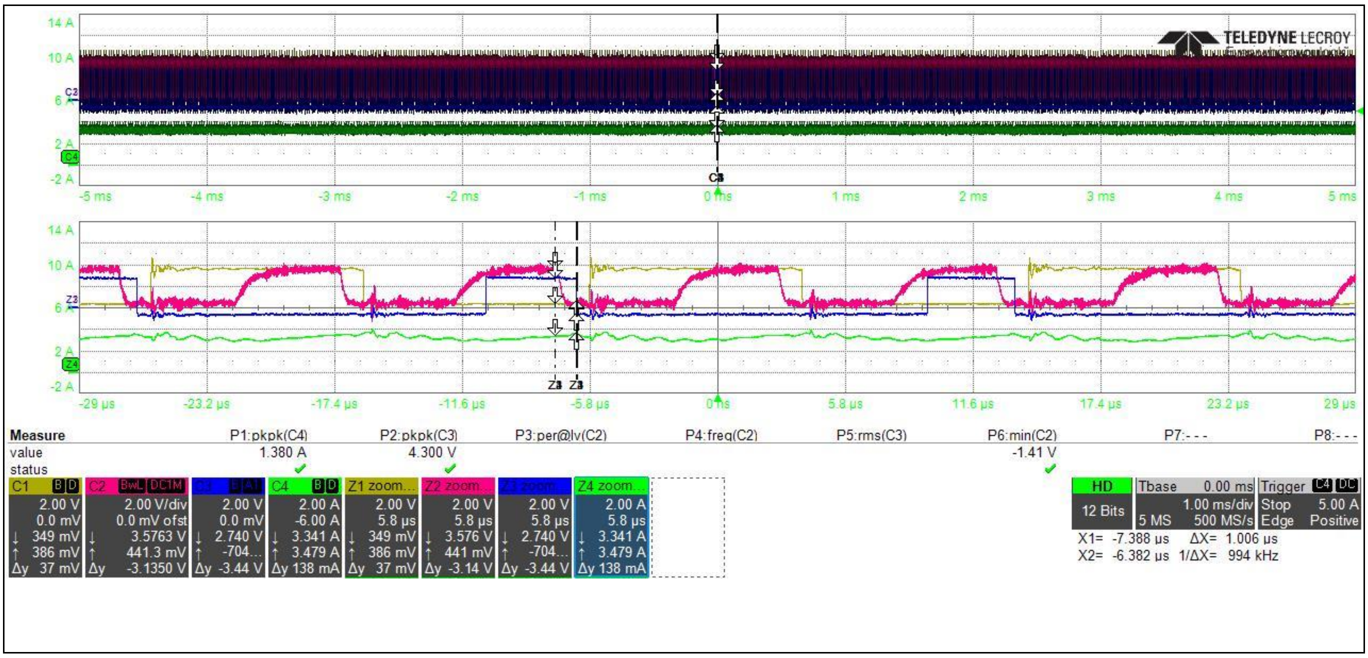

Figure 15 Synchronous rectification gate signal

2.3 Auxiliary power boards

2.3.1 The technical specification of auxiliary power boards

The reference board is intended to support customers designing an auxiliary power supply for three-phase converters using the Infineon 1700 V CoolSiC™ MOSFET. Potential applications include solar inverters, energy storage, EV chargers, UPS and motor drives. Table 2 lists the key board specifications.

Table 3 Technical specifications

Input voltage	300 V_{DC} to 900 V_{DC}
Output power	32 W
Topology	Single-ended flyback
Output voltage	20 V
Tolerance	2%
Output current	2 A
Frequency	65~130 kHz, QR mode
Derating of switches V_{DS}	85% (1450 V)
Efficiency at full load	>85%

2.3.2 Auxiliary power board description

The auxiliary power boards was developed using the 1700 V CoolSiC™ MOSFET in a single-ended flyback topology to provide auxiliary power for these DC-DC converters.

The board has 20V outputs with up to 32 W output power working in a wide input voltage range from 200 V_{DC} to 850 V_{DC}. Its potential applications are any power electronic system having a high input voltage DC link.

This user guide contains an overview of the reference board's operation, product information and technical details with measurement results. The board uses 1700 V CoolSiC™ MOSFET in a TO-263 7L surface-mounted device (SMD) package as the main switch, which is well suited for high input voltage DC link, with single-ended flyback topology. With low $R_{DS(on)}$, high efficiency and low device temperature rise can be achieved with this board.

The controller works in quasi-resonant mode to help reduce EMI noise. This information can help customers during their design-in phase, and for re-use of the reference design board for their own specific requirements.

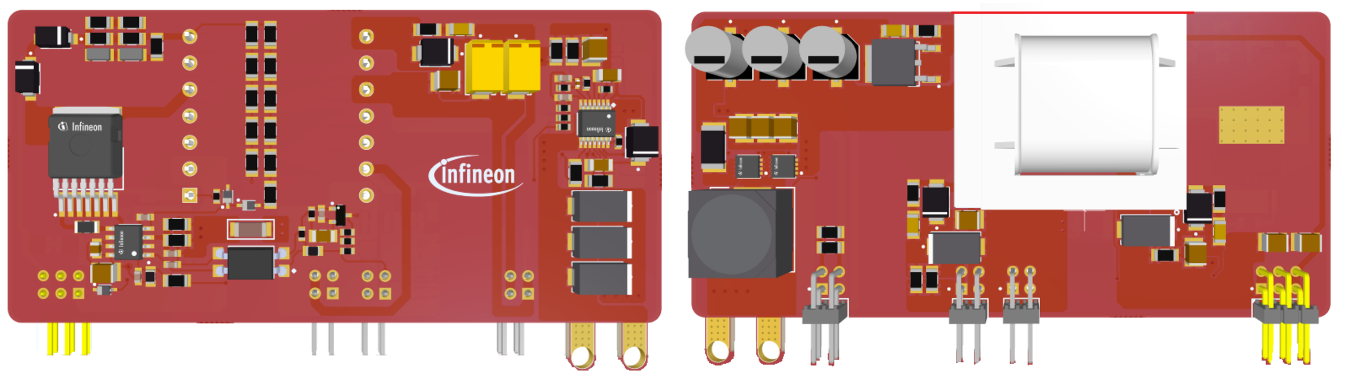

Figure 16 Pictures of auxiliary power board

2.3.3 1700 V CoolSiC™ MOSFET overview

The auxiliary power board was developed using the 1700 V CoolSiC™ MOSFET in a single-ended flyback topology to provide auxiliary power for this DC-DC. The 1700 V CoolSiC™ MOSFET from Infineon is an excellent choice for high input voltage DC link systems like those found in auxiliary power supplies for three-phase converters. The TO-263 7L surface-mounted device (SMD) package is an optimized package for up to 1700 V high voltage power device. There is a creepage distance of about 7 mm width between drain and source, so safety standards are easily met. The separate driver source pin is helpful in reducing parasitic inductance of the gate loop to prevent gate-ringing effects.

Using Infineon's 1700 V CoolSiC™ MOSFET can simplify the current auxiliary power supply designs by developing a single-ended flyback reference design board. For a low-power auxiliary power supply, a flyback is the most common topology due to its simple design. However, the flyback topology requires a switching device with a high-blocking voltage. Currently, silicon MOSFETs only have a blocking voltage of up to 1500 V that leaves low design margins, which affects the reliability of the power supply at a given input voltage DC link of 1000 V_{DC}. Moreover, most 1500 V silicon MOSFETs have very large on-state resistance ($R_{DS(on)}$), which will lead to higher losses, and thus lower system efficiency.

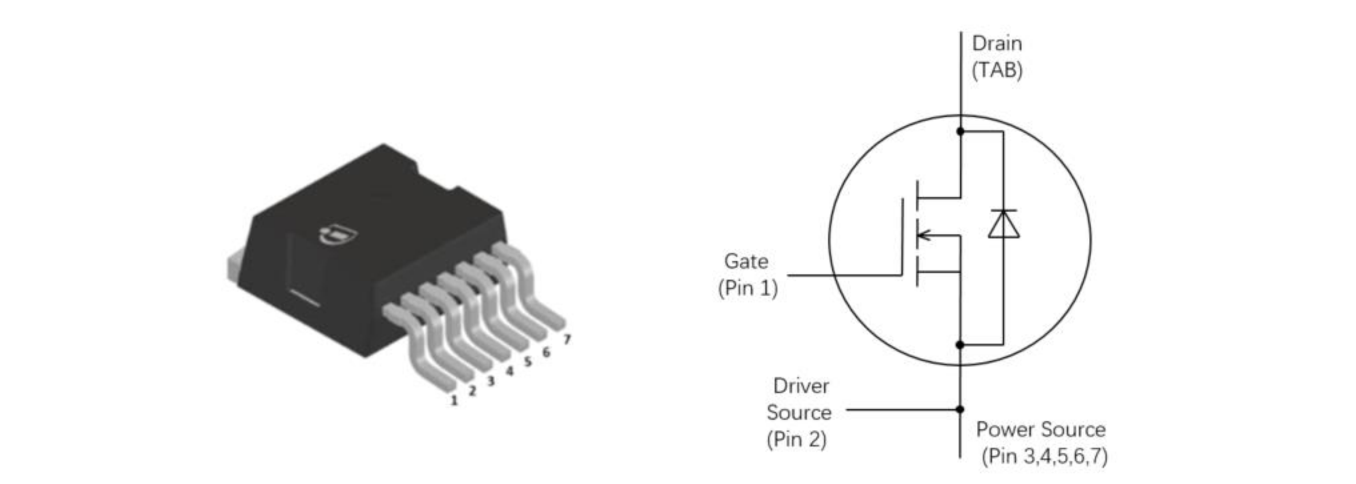

Figure 17 1700 V CoolSiC™ MOSFET IMBF170R1K0M1

The ICE5QSAG gate drive output stage has a 0.9 A source capability, and output voltage up to 13 V, so the SiC MOSFET can be driven directly, which simplifies the driver circuit design.

The auxiliary power board was developed using the 1700 V CoolSiC™ MOSFET in a single-ended flyback topology to provide auxiliary power for this DC-DC. The 1700 V CoolSiC™ MOSFET from Infineon is an excellent choice for high input voltage DC link.

2.4 User interface

The 11 kW bi-directional DC-DC converter includes Wi-Fi wireless communication and the corresponding protocol, allowing the converter system to implement the following functions through the GUI interface of the computer:

- System parameter setting (output direction, synchronous rectification function, output voltage/current, voltage/current protection)
- Working status control (connection, start/stop)
- Running status display (measured value)
- Abnormal status monitoring (fault register)
- Abnormal analysis data reading (tools)

The signal chain between the GUI control interface and the converter system is the computer GUI interface -> PC Wi-Fi connection -> DC-DC converter system as shown in Figure 18.

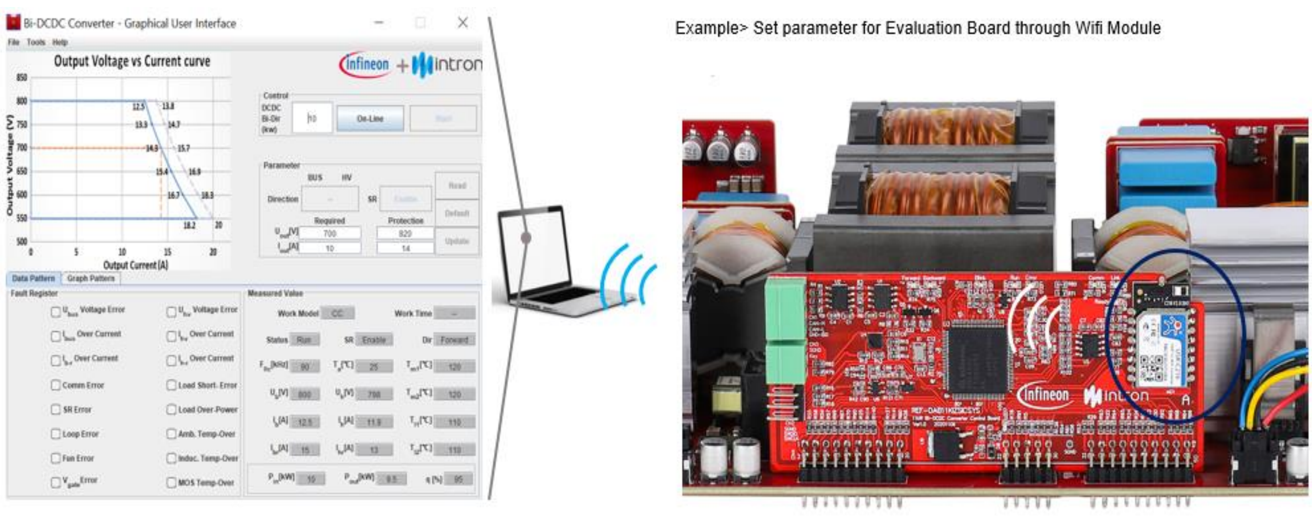

Figure 18 Signal chain between the GUI control interface and the converter system

The corresponding human-machine interface realizes corresponding functions through the combination of graphics + data + buttons. The detailed interface is shown in the figure below:

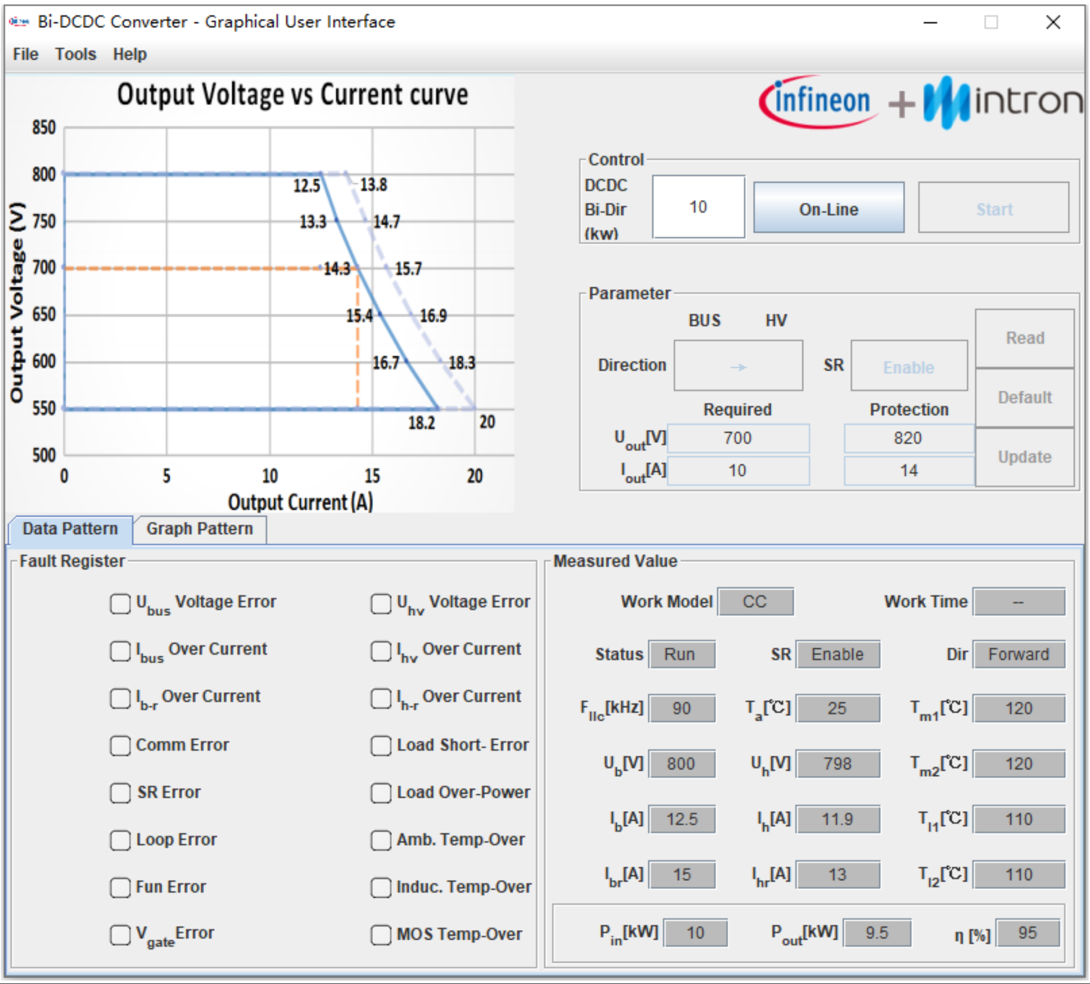

Figure 19 Graphical user interface (GUI)

There are two ways for the GUI to display real-time data:

- Data dattern: Data parameter interface displays:

  Working status, operating voltage/current, resonance parameters, temperature of key components, abnormal status monitoring and display.

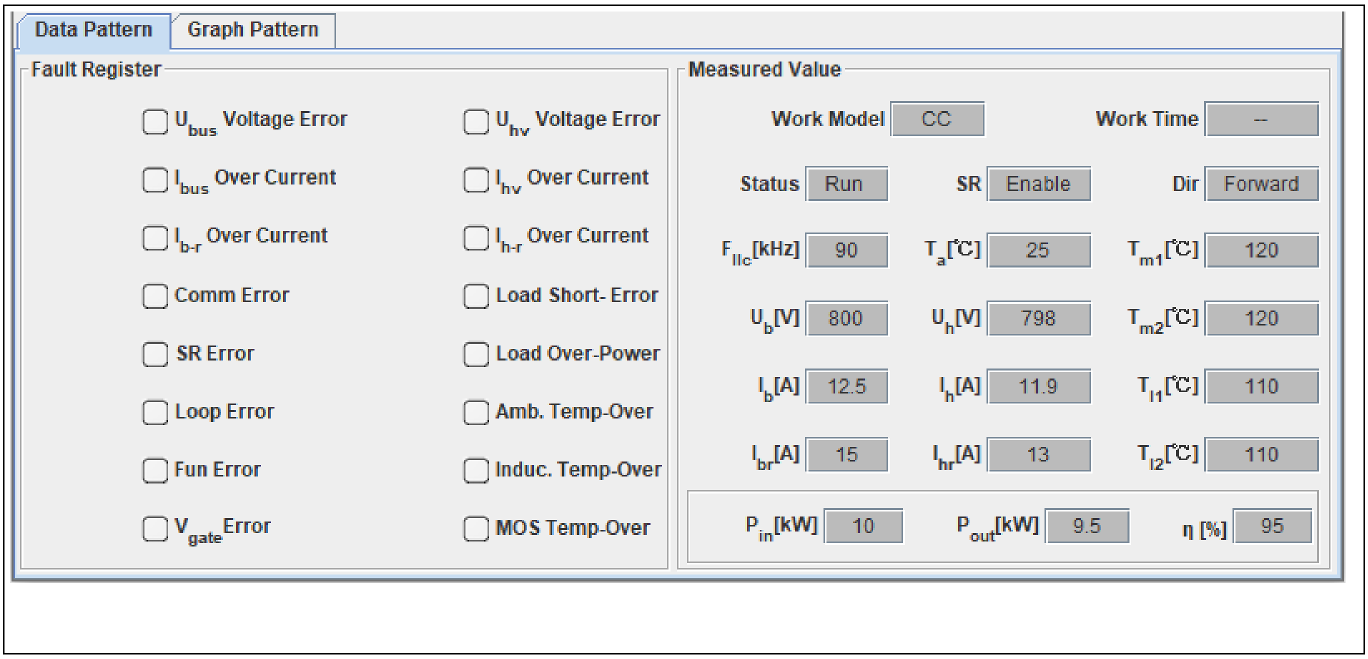

Figure 20 Data pattern in GUI user

- Graph Pattern： Graphical parameter interface displays:

  Relevant real-time operating data of components in the corresponding position of topology of the system.

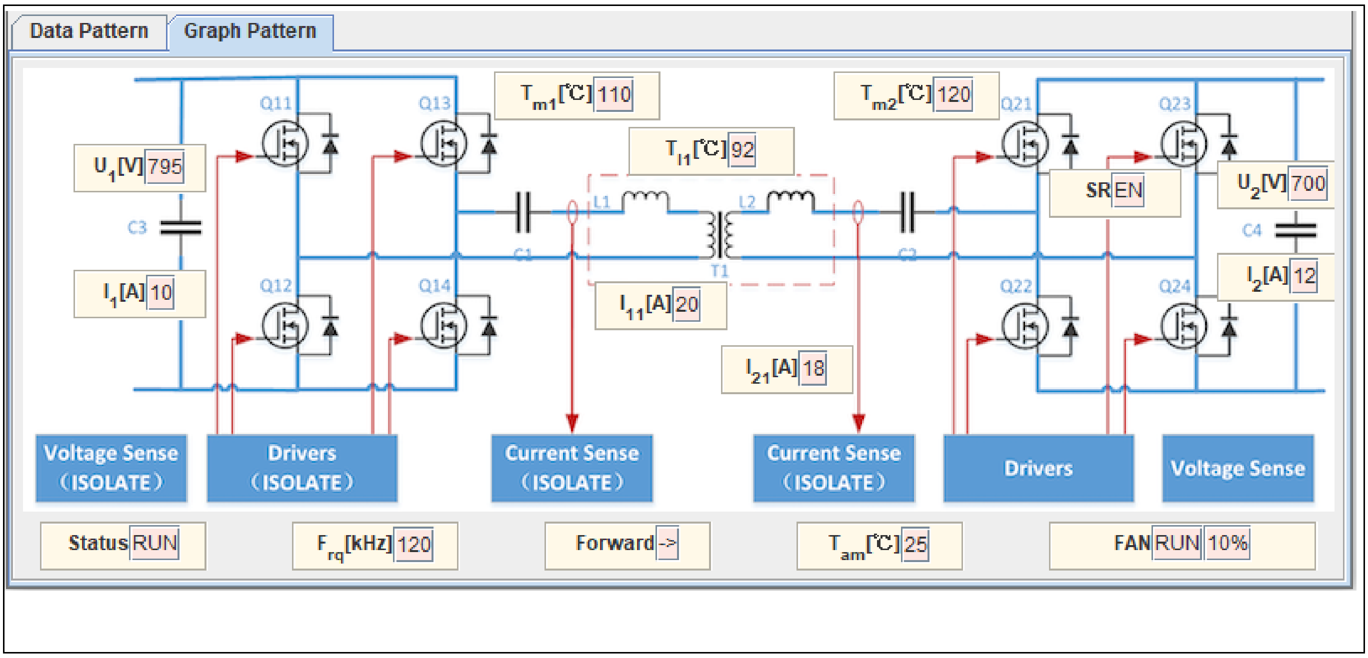

Figure 21 Graph pattern in GUI user

2.5 Efficiency plots

The efficiency plots reported here are measured with forward direction and reverse direction by high performance power analyzer as shown in below firgure**Error! Reference source not found.**, the equipment WT1800 on the right side is the power analyzer, below it is a DC power supply. You can also see our 11 kW bi-directional CLLC DC-DC converter is on the left sides.

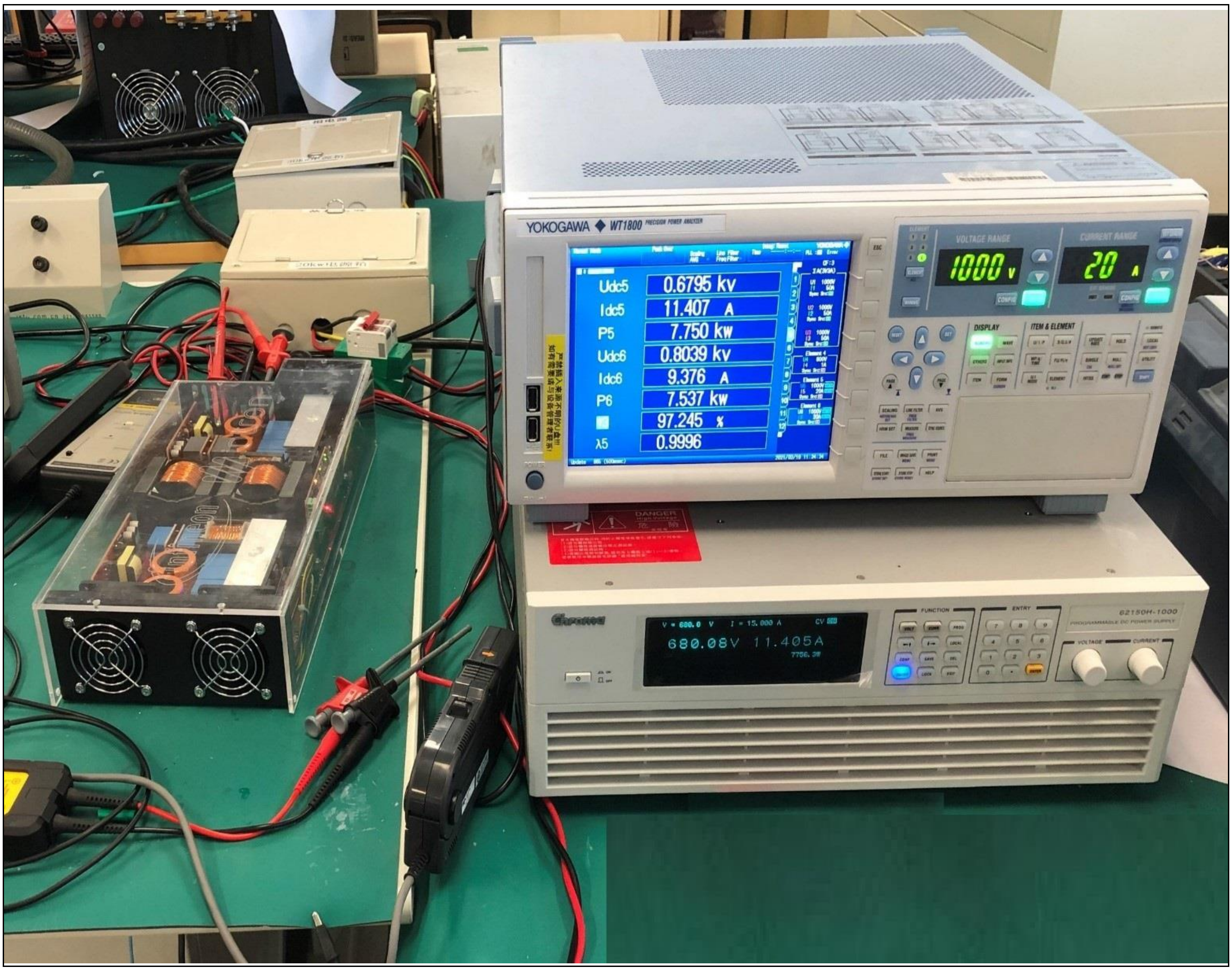

Figure 22 Efficiency test environment

The efficiency plots shown in Figure 23 and Figure 24 has been measured under different conditions with different output power & voltage, it also include the power loss from the fan which is supplied by the auxiliary power board inside the system.

The maximum efficiency is 97.26% in reverse working mode when the output voltage is 800 V, bus voltage is 680 V, and output power is 6.67 KW. A further improvement with the implantation of synchronous rectification is in progress, it is expected that the efficiency can be improved by 0.2~0.3%.

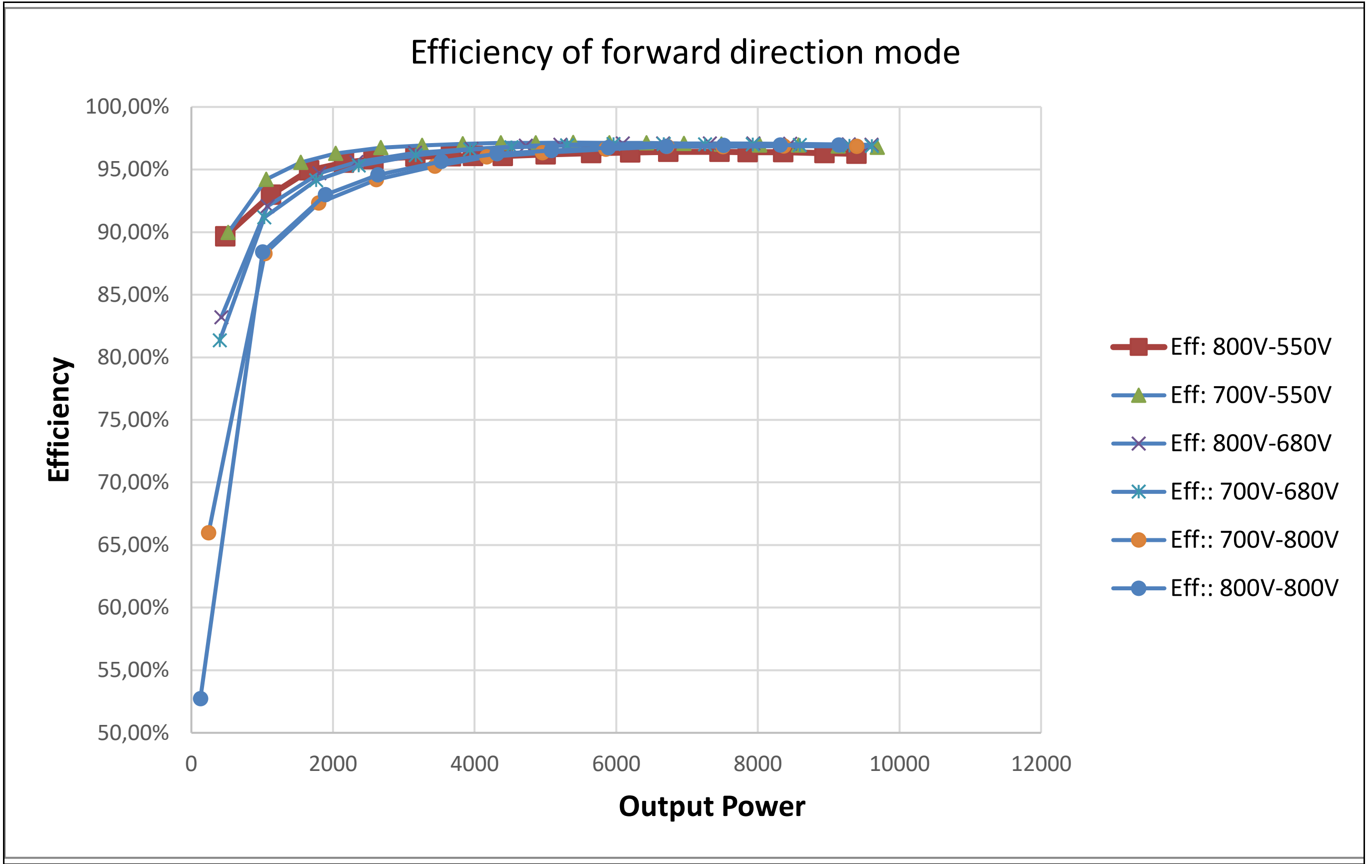

Figure 23 Efficiency of forward direction

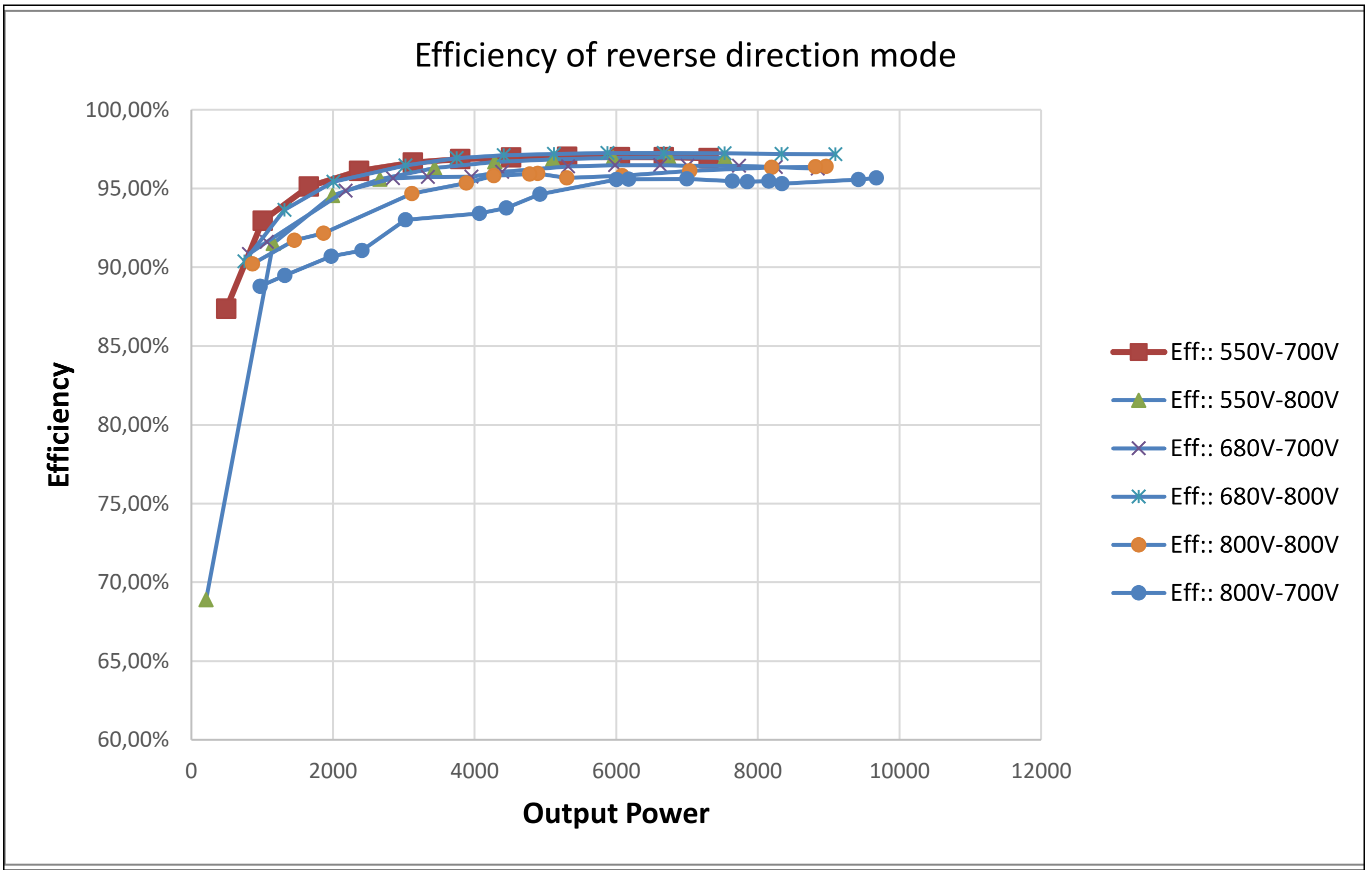

Figure 24 Efficiency of reverse direction

3 System design

3.1 Schematics

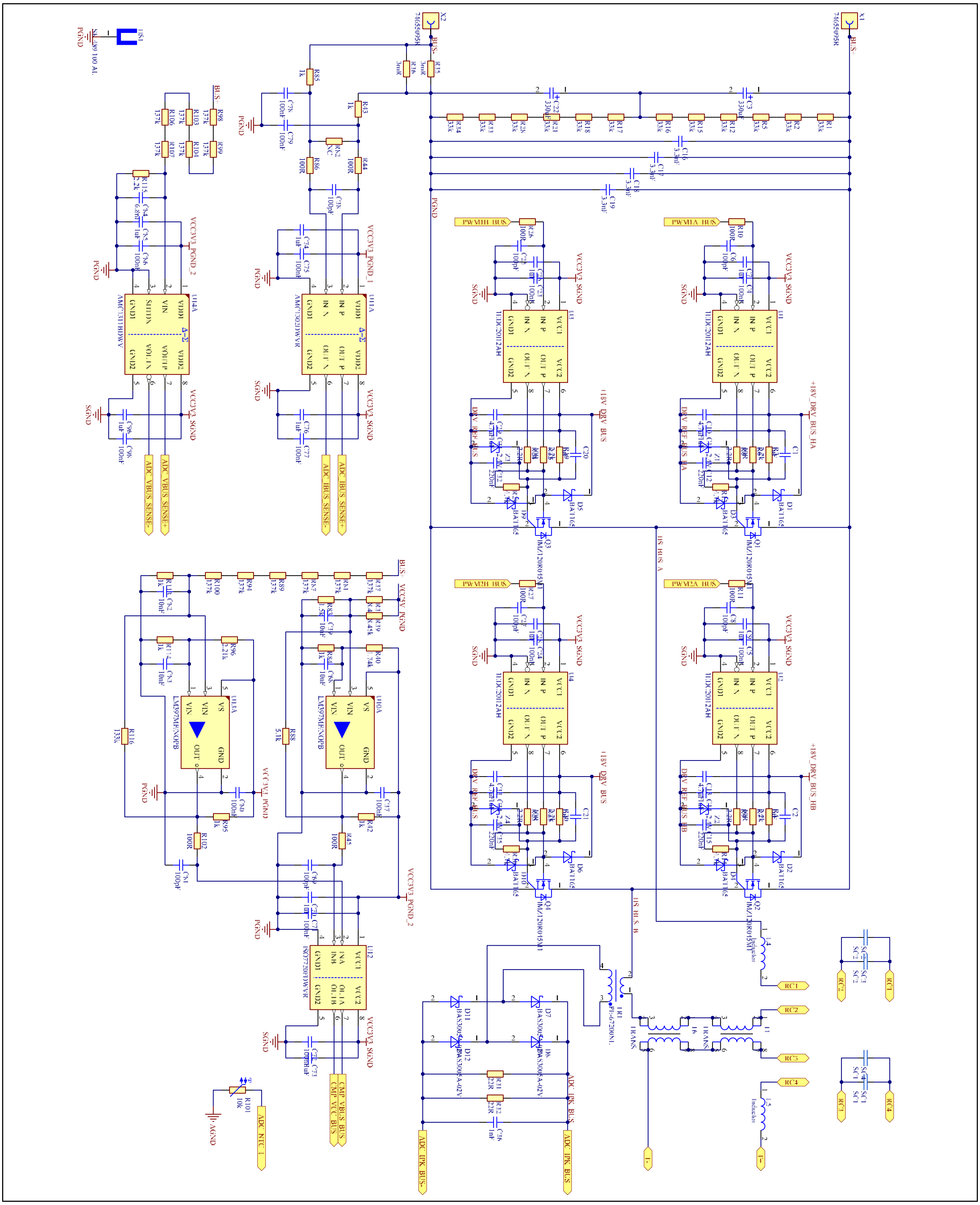

Figure 25 Main board primary side schematic

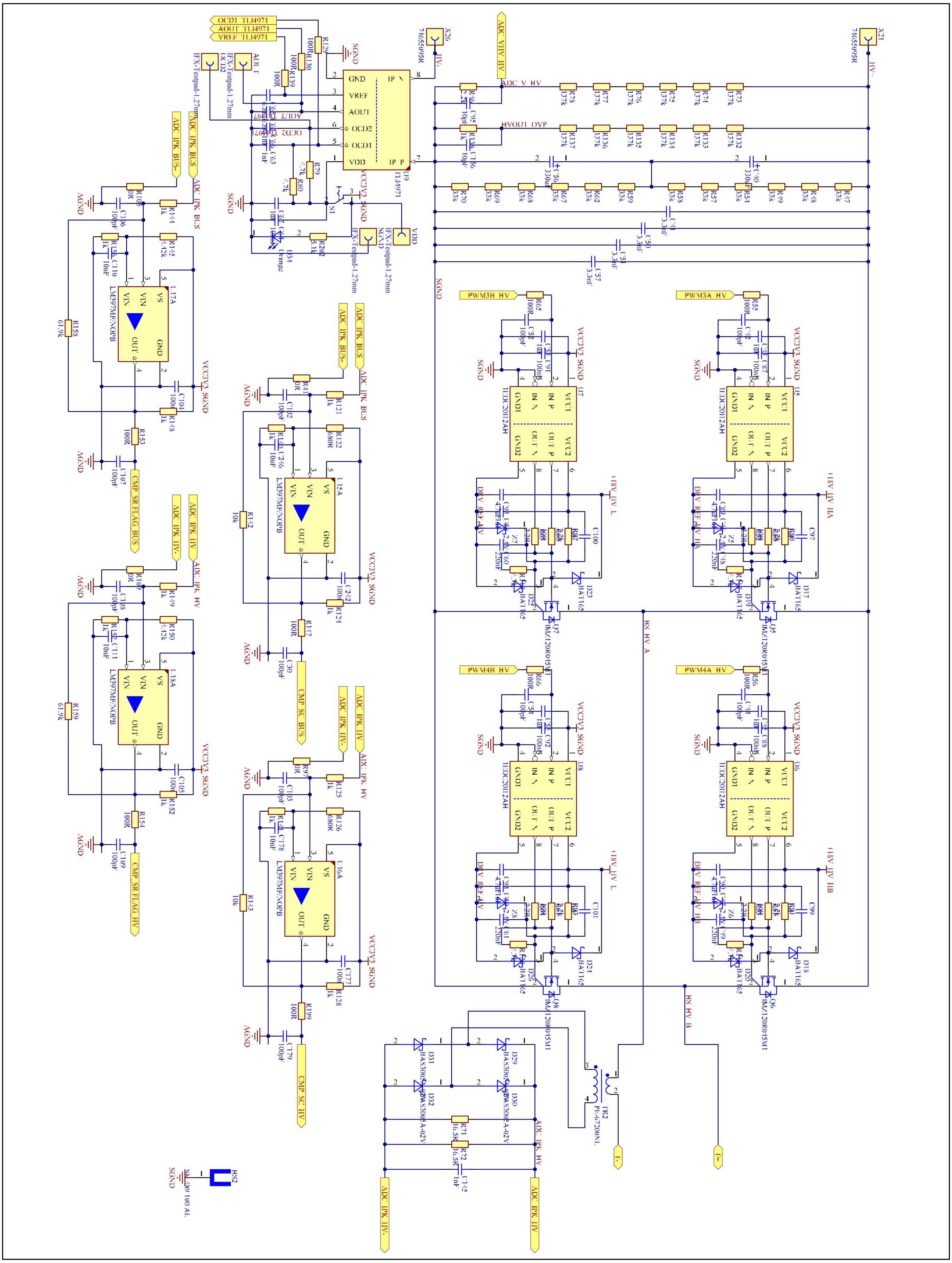

Figure 26 Main board secondary side schematic

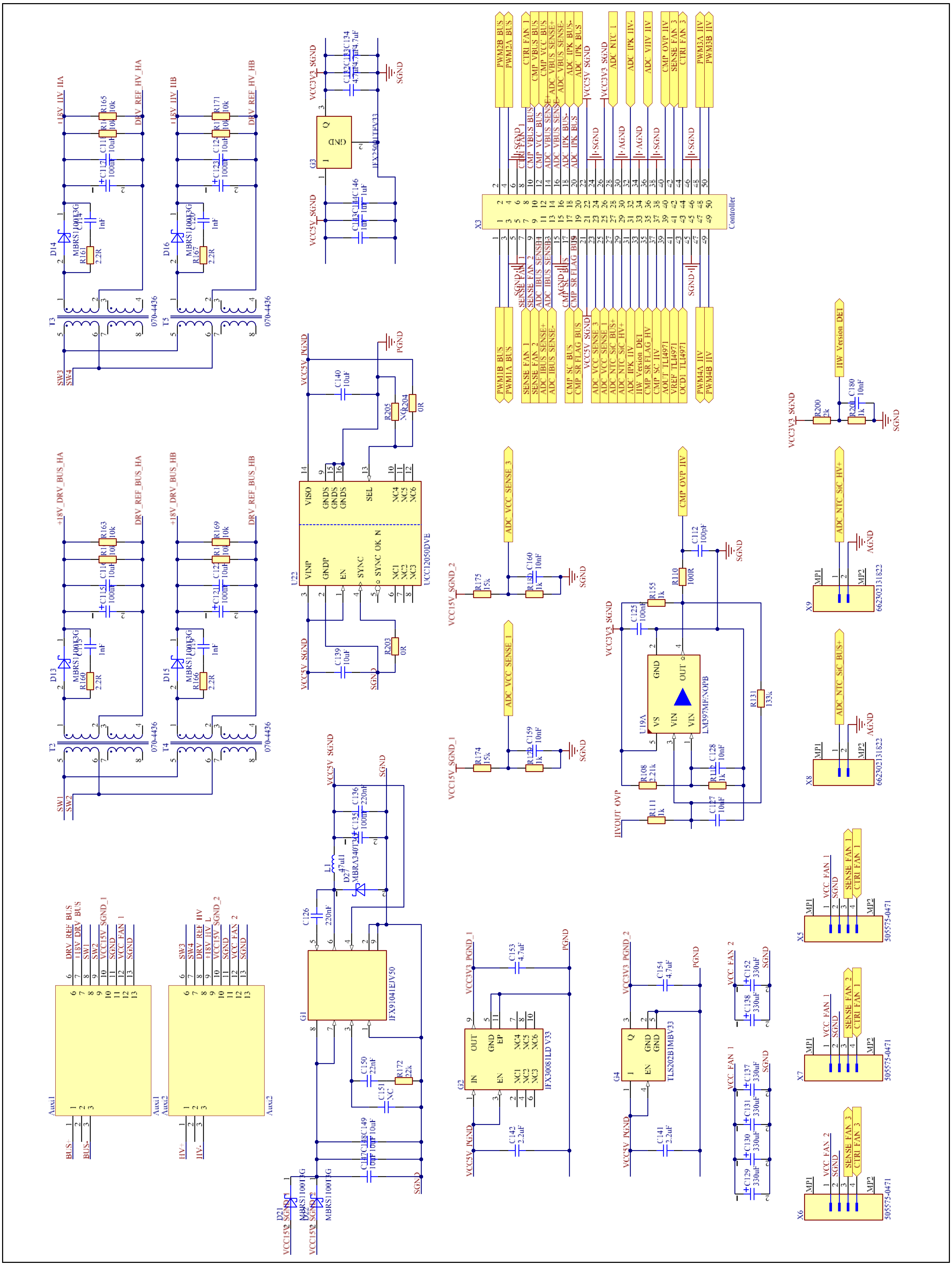

Figure 27 Sensor circuit schematic

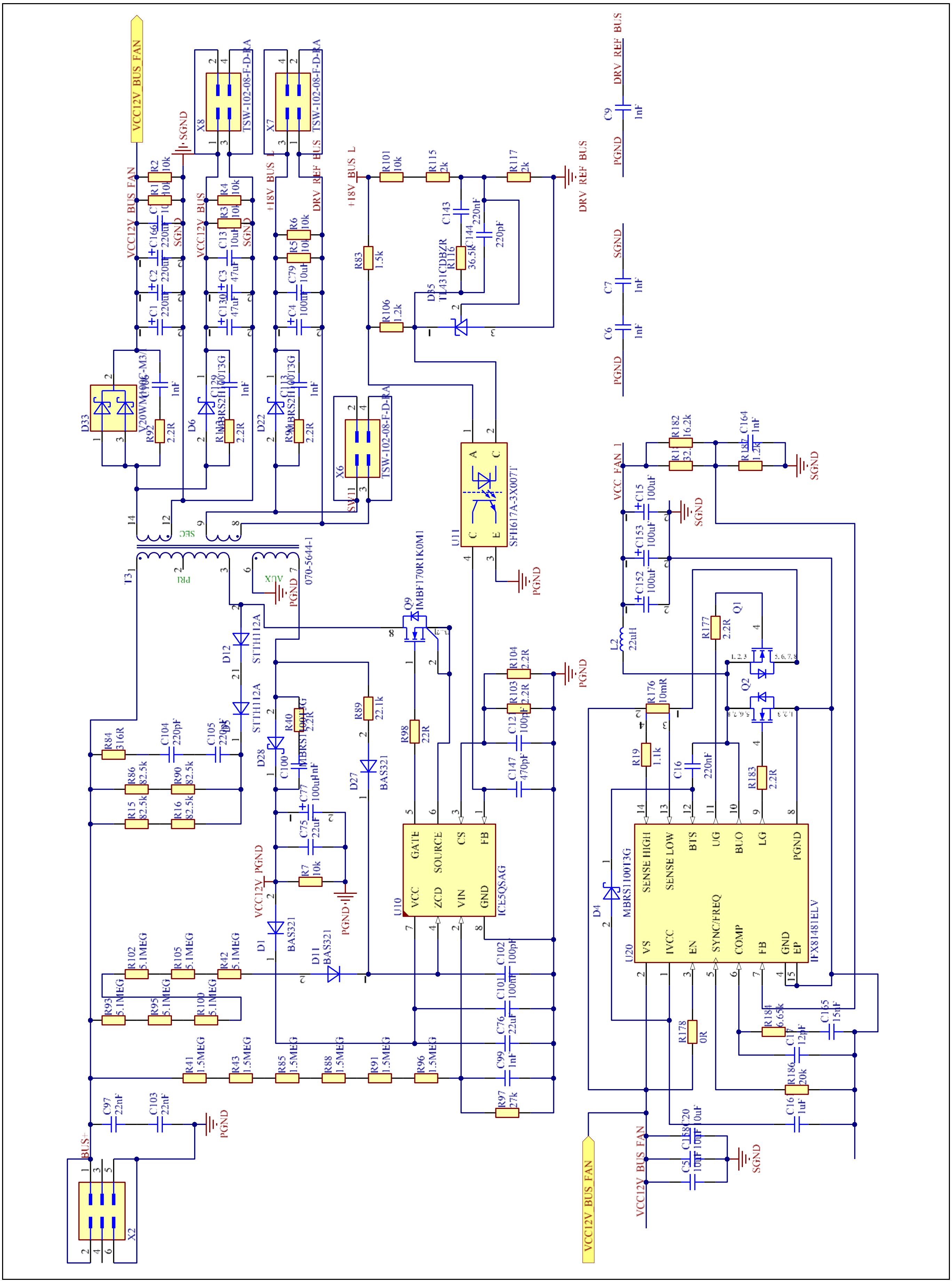

Figure 28 Primary side 32 W auxiliary power supply schematic.

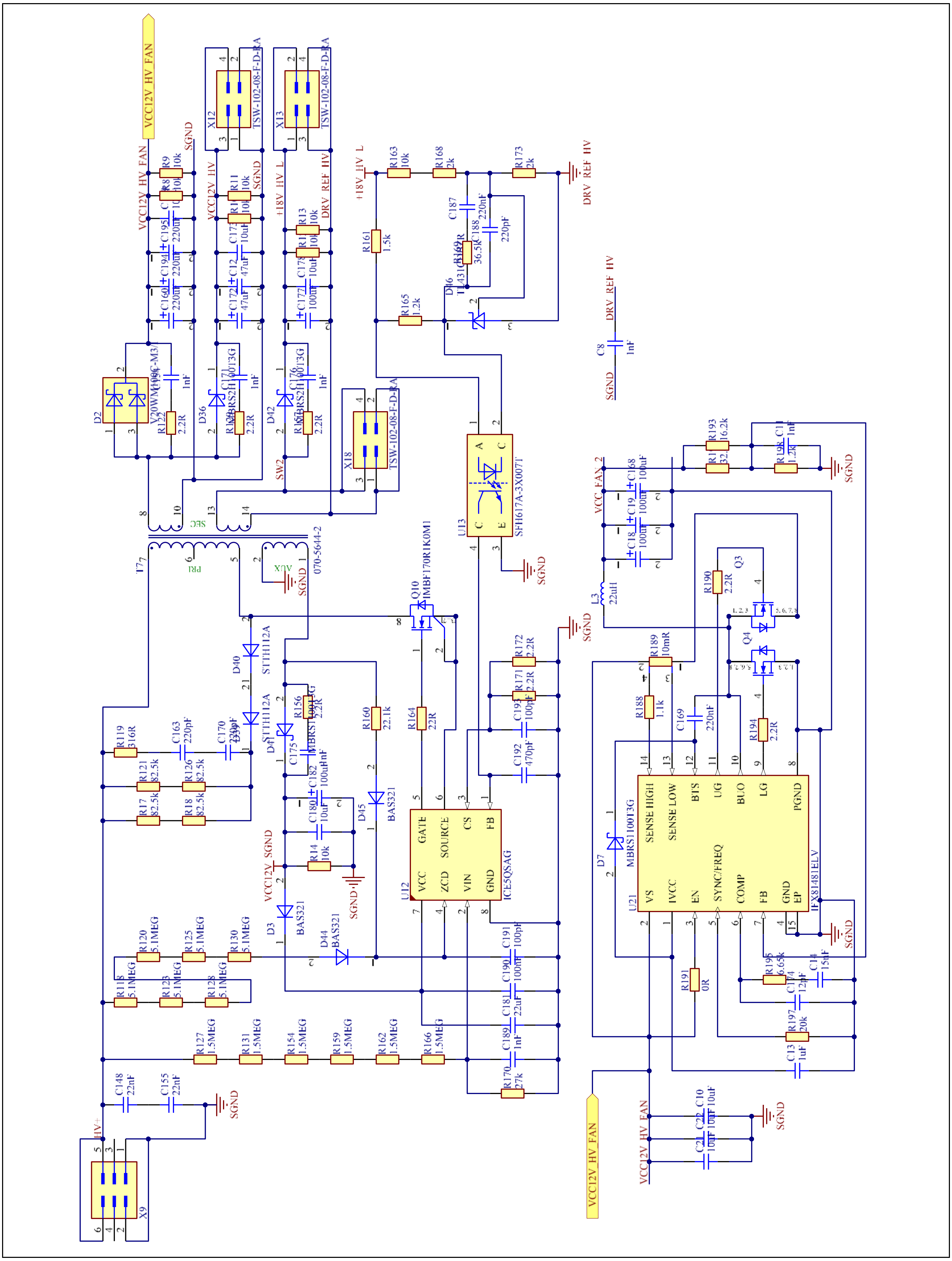

Figure 29 Secondary side 32 W auxiliary power supply schematic.

3.2 Layout

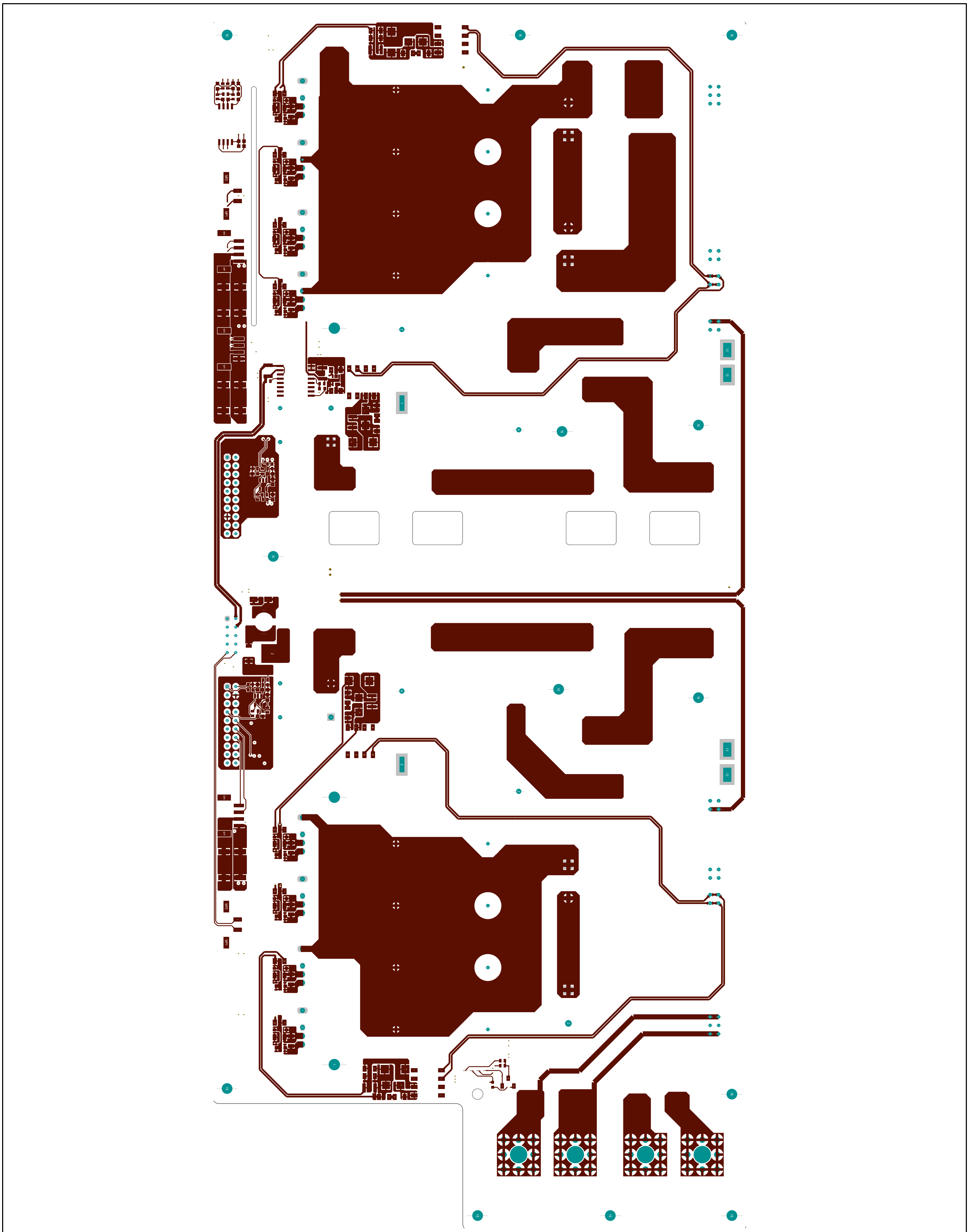

Figure 30 Top Layer

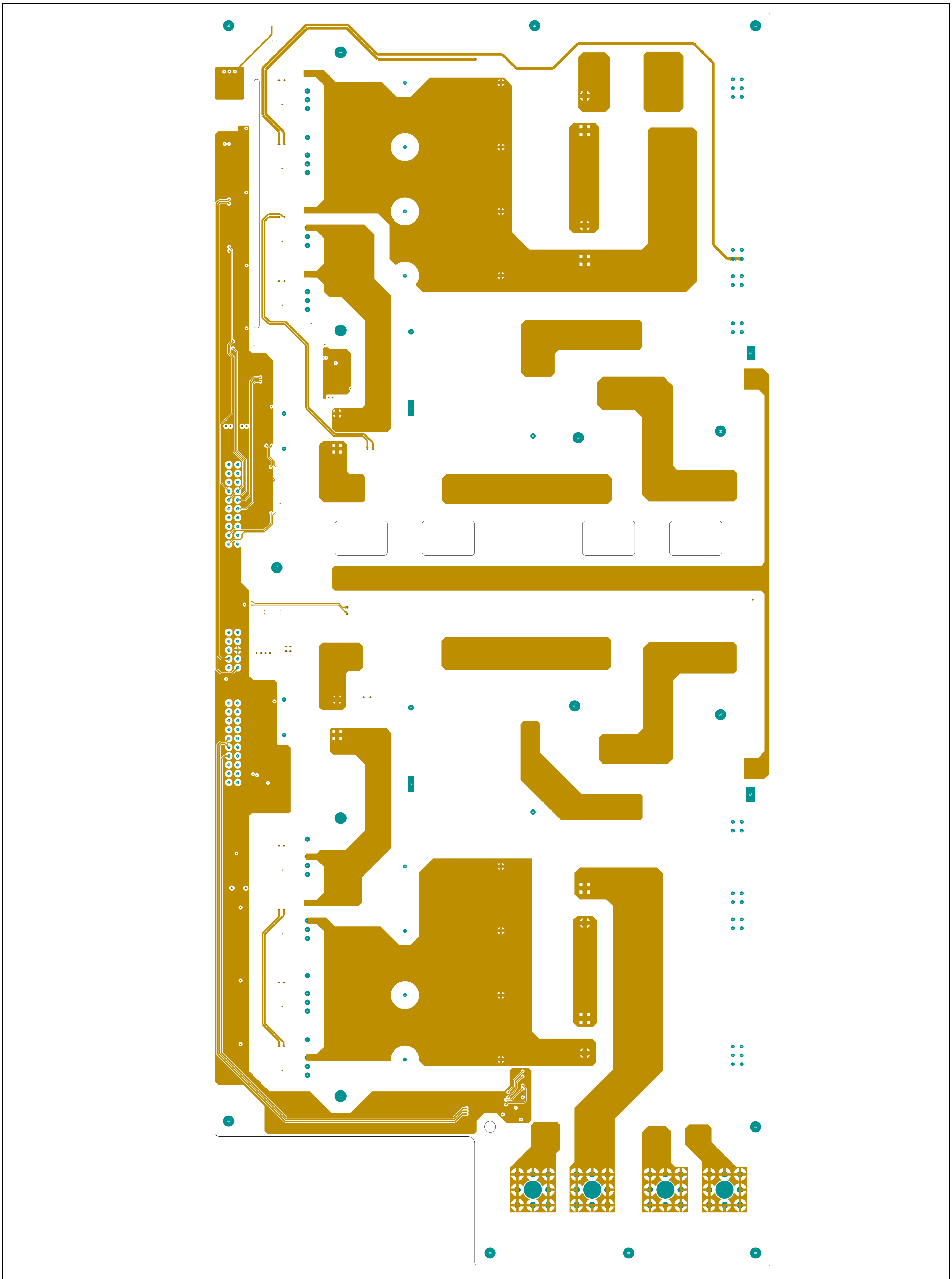

Figure 31 Layer 2

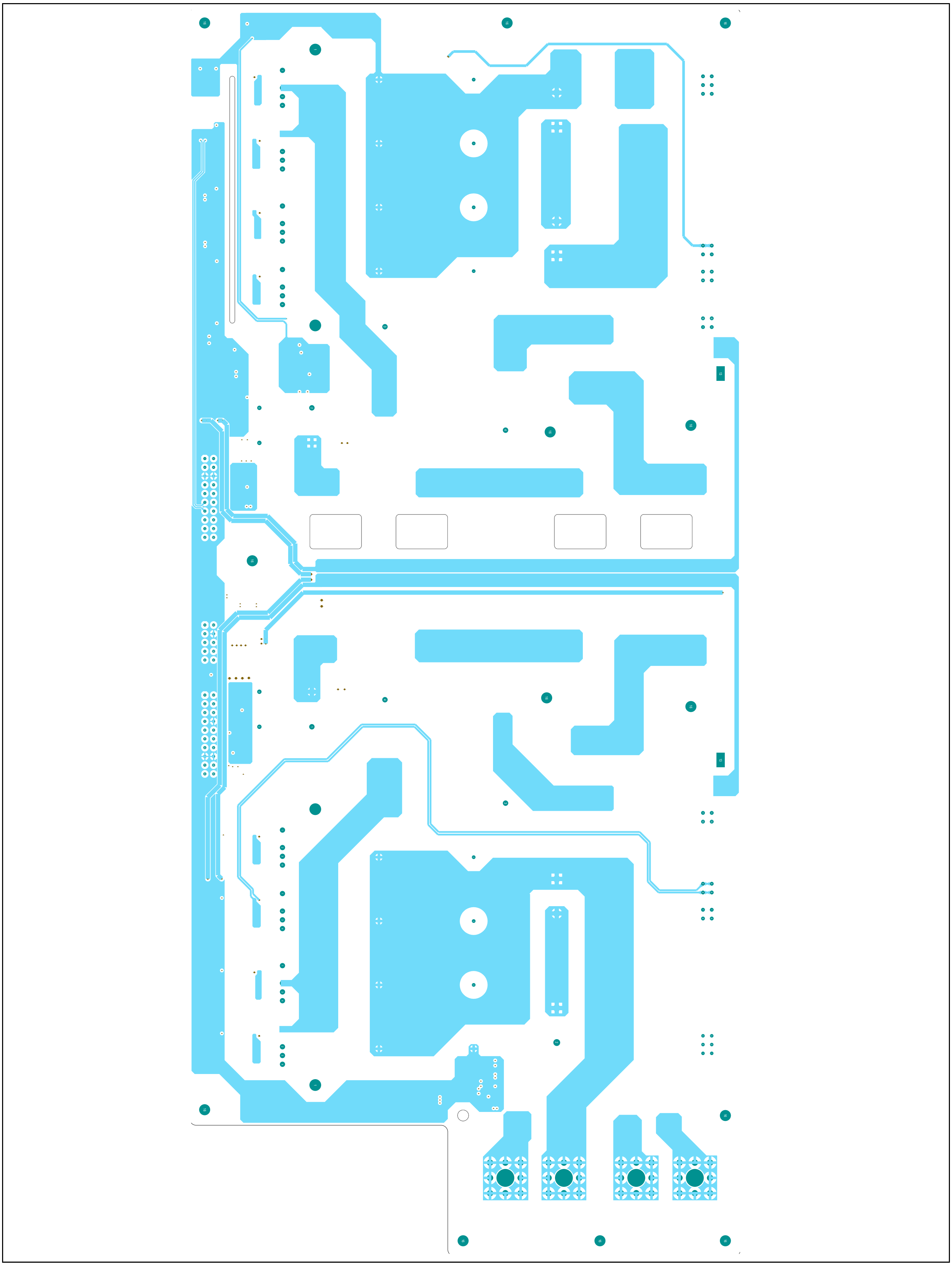

Figure 32 Layer 3

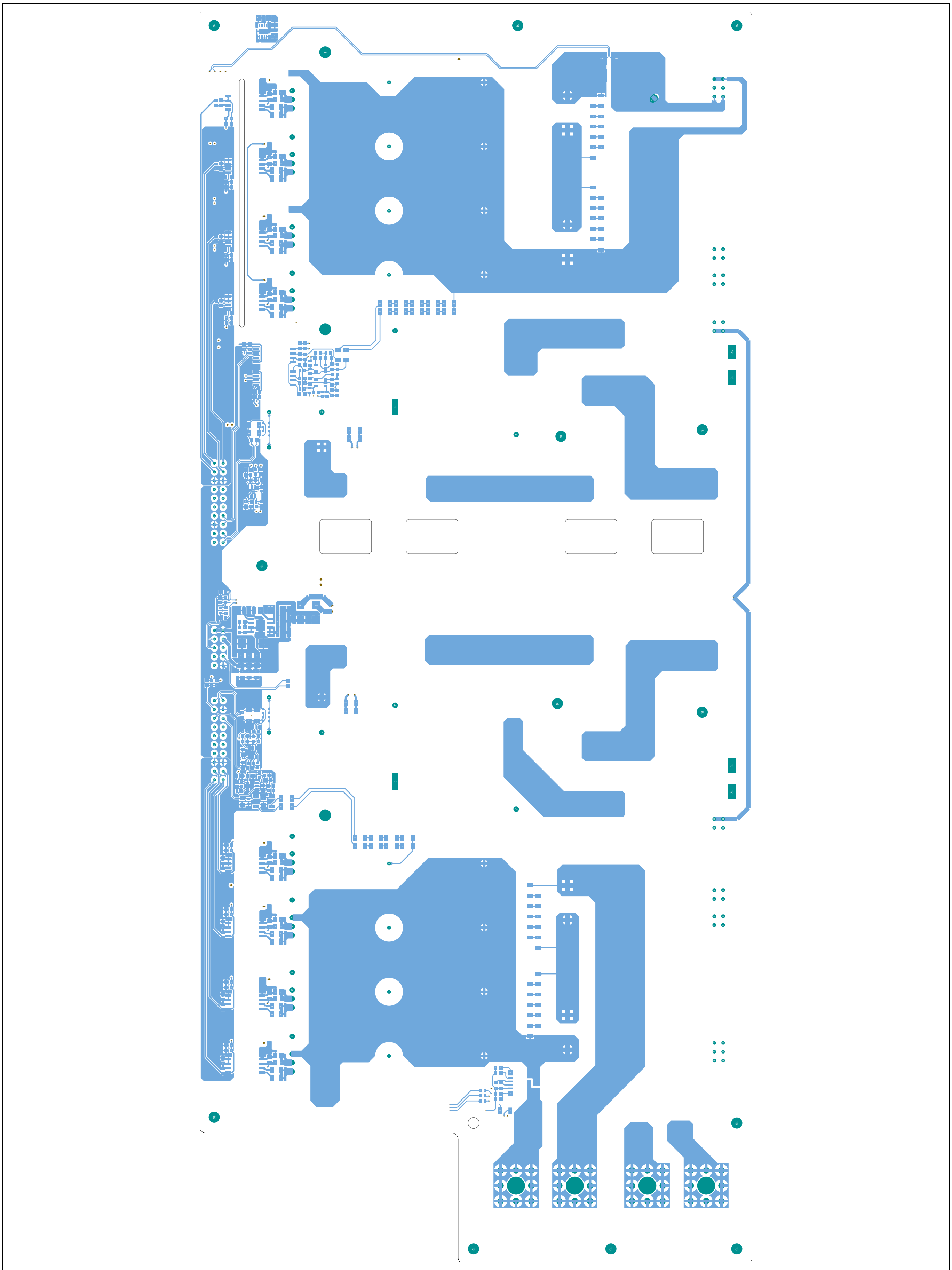

Figure 33 Bottom Layer

3.3 Bill of material

The complete bill of material is available on the download section of the Infineon homepage. A log-in is required to download this material.

Table 4 BOM of the most important/critical parts of the reference board

Quantity	Designator	Value	Footprint	Description	Manufacturer
2	C107, C115	12nF	CAPRR2250W80L2650T600H1500B	CAP / FILM / 12nF / 2kV / 5% / MKP (Metallized Polypropylene) / -55Â°C to 110Â°C / 22.50mm C X 0.80mm W 26.50mm L X 6.00mm T X 15.00mm H / - / -	TDK Corporation
18	C108, C109, C110, C111, C112, C114, C116, C117, C118, C119, C120, C138, C139, C140, C141, C142, C196, C197	18nF	CAPRR2250W80L2650T600H1500B	CAP / FILM / 18nF / 2kV / 5% / MKP (Metallized Polypropylene) / -55Â°C to 110Â°C / 22.50mm C X 0.80mm W 26.50mm L X 6.00mm T X 15.00mm H / - / -	TDK Corporation
2	C107, C115	12nF	CAPRR2250W80L2650T600H1500B	CAP / FILM / 12nF / 2kV / 5% / MKP (Metallized Polypropylene) / -55Â°C to 110Â°C / 22.50mm C X 0.80mm W 26.50mm L X 6.00mm T X 15.00mm H / - / -	TDK Corporation
18	C108, C109, C110, C111, C112, C114, C116, C117, C118, C119, C120, C138, C139, C140, C141, C142, C196, C197	18nF	CAPRR2250W80L2650T600H1500B	CAP / FILM / 18nF / 2kV / 5% / MKP (Metallized Polypropylene) / -55Â°C to 110Â°C / 22.50mm C X 0.80mm W 26.50mm L X 6.00mm T X 15.00mm H / - / -	TDK Corporation
2	C107, C115	12nF	CAPRR2250W80L2650T600H1500B	CAP / FILM / 12nF / 2kV / 5% / MKP (Metallized Polypropylene) / -55Â°C to 110Â°C / 22.50mm C X 0.80mm W 26.50mm L X 6.00mm T X 15.00mm H / - / -	TDK Corporation
3	C1, C2, C166	220uF	CAPAE660X800N-3	CAP / ELCO / 220uF / 25V / 20% / Aluminiumelectrolytic / -55¡ãC to 105¡ãC / 6.60mm L X 6.60mm W X 8.00mm H / SMD / -	Panasonic
4	C3, C12, C130, C172	47uF	CAPMP7343X430N	CAP / ELCO / 47uF / 35V / 10% / Tantalumoxide / -55¡ãC to 125¡ãC / 7.30mm L X 4.30mm W X 4.30mm H / - / -	Kemet
10	C4, C15, C18, C19, C77, C152, C153, C168, C177, C182	100uF	CAPMP7343X310N-1	Polymer Surface Mount Chip Capacitor Molded Case, High Performance Type, CAP / ELCO / 100uF / 25V / 20% / Tantalumelectrolytic /	Vishay

				-55Â°C to 105Â°C / 7.30mm L X 4.30mm W X 3.10mm H / SMD / -	
14	C5, C10, C20, C21, C22, C71, C75, C79, C131, C158, C159, C173, C178, C180	10uF	1210	CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -, CAP / - / 10uF / 50V / 20% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -, CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -, CAP / CERA / 10uF / 50V / 20% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -	TDK Corporation
4	C6, C7, C8, C9	1nF	1808	Multilayer Ceramic Chip Capacitor	TDK Corporation
4	C11, C99, C164, C189	1nF	0603	CAP / CERA / 1nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
2	C13, C161	1uF	1206	CAP / - / 1uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -	TDK Corporation
2	C14, C165	15nF	0603	CAP / - / 15nF / 35V / 5% / C0G (EIA) / -55Â°C to 125Â°C / 0603(1608) / SMD / -	TDK Corporation
4	C16, C143, C169, C187	220nF	1206	CAP / - / 220nF / 100V / 5% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -, CAP / - / 220nF / 16V / 5% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -	TDK Corporation
2	C17, C174	12pF	0402	CAP / - / 12pF / 50V / 2% / C0G (EIA) / NP0 / -55Â°C to 125Â°C / 0402(1005) / SMD / -	TDK Corporation
2	C76, C181	22uF	1210	CAP / CERA / 22uF / 25V / 20% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -	TDK Corporation
4	C97, C103, C148, C155	22nF	1206	Chip Monolithic Ceramic Capacitor	TDK Corporation
8	C100, C106, C113, C129, C154, C171, C175, C176	1nF	1206	CAP / CERA / 1nF / 630V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
2	C101, C190	100nF	0805	CAP / CERA / 100nF / 100V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
4	C102, C121, C191, C193	100pF	0603	CAP / CERA / 100pF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
4	C104, C105, C163, C170	220pF	CAPC3216X100N	Chip Monolithic Ceramic Capacitor	MuRata
2	C144, C188	220pF	0603	CAP / CERA / 220pF / 50V / 5% / C0G	TDK Corporation

				(EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	
2	C147, C192	470pF	0603	CAP / CERA / 470pF / 50V / 2% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
3	C160, C194, C195	220uF	CAPAE660X800N-1	CAP / ELCO / 220uF / 25V / 20% / Aluminiumelectrolytic / -55¡ãC to 105¡ãC / 6.60mm L X 6.60mm W X 8.00mm H / SMD / -	Panasonic
6	D1, D3, D11, D27, D44, D45	BAS321	SOD2513X110N-1	General Purpose Diode	Nexperia
2	D2, D33	V20WM100C-M3/I	TO229P1003X238-4_3N	Dual Trench MOS Barrier Schottky Rectifier	Vishay
4	D4, D7, D28, D41	MBRS1100T3G	DIOM5436X247N	Schottky Power Rectifier	ON Semiconductor
4	D5, D12, D39, D40	STTH112A	DIOM5126X265N	High voltage ultrafast rectifier	STMicroelectronics
4	D6, D22, D36, D42	MBRS2H100T3G	DIOM5436X247N	Surface Mount Schottky Power Rectifier, 2.0A/100V	ON Semiconductor
2	D35, D46	TL431CDBZR	SOT95P237X112-3N-1	Precision Programmable Reference	Texas Instruments
2	L2, L3	22uH	INDP120120X81N	IND / STD / 22uH / 2.9A / 20% / -40Â°C to 125Â°C / 35.5mR / SMD / 12mmx12mmx8.1mm / SMD / -	Coilcraft
4	Q1, Q2, Q3, Q4	BSZ068N06NS	INF-PG-TSDSON-8-FL	OptiMOS Power - MOSFET, 60 V	Infineon Technologies
2	Q9, Q10	IMBF170R1K0M1	TO127P1500X470-8N-1	Coolsic Trench Silicon Carbide MOSFET, very loss switching losses, optimized for fly-back topologies, applications in energy generation, industrial power supplies, infrastructure-charger	Infineon Technologies
14	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14	10k	RESC3216X60N	RES / STD / 10k / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
8	R15, R16, R17, R18, R86, R90, R121, R126	82.5k	RESC3216X60N	RES / STD / 82.5k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R19, R188	1.1k	RESC1609X50N	RES / STD / 1.1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
16	R40, R92, R94, R103, R104, R113, R122, R129, R156, R157, R171, R172, R177, R183, R190, R194	2.2R	RESC3216X60N	Standard Thick Film Chip Resistor, RES / STD / 2.2R / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -, RES / STD / 2.2R / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
12	R41, R43, R85, R88,	1.5MEG	RESC3216X60N	RES / STD / 1.5MEG / 250mW / 1% /	Vishay

	R91, R96, R127, R131, R154, R159, R162, R166			100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	
12	R42, R93, R95, R100, R102, R105, R118, R120, R123, R125, R128, R130	5.1MEG	RESC3216X60N	RES / STD / 5.1MEG / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R83, R161	1.5k	RESC2113X50N	Standard Thick Film Chip Resistor	Vishay
2	R84, R119	316R	RESC3216X60N	Standard Thick Film Chip Resistor	Vishay
2	R89, R160	22.1k	RESC1609X50N	RES / STD / 22.1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
1	R97	27k	RESC1609X50N	RES / STD / 27k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R98, R164	22R	RESC3216X65N-1	RES / STD / 22R / 500mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
2	R101, R163	12k	RESC1609X50N	RES / STD / 12k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
4	R106, R165, R187, R198	1.2k	RESC1609X50N	RES / STD / 1.2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
4	R115, R117, R168, R173	2k	RESC1609X50N	Standard Thick Film Chip Resistor	Vishay
2	R116, R169	36.5k	RESC1609X50N	Standard Thick Film Chip Resistor	Vishay
1	R170	27k	RESC2113X50N	RES / STD / 27k / 125mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0805 / SMD / -	Vishay
2	R176, R189	10mR	RESC6432X89N-1_4p	RES / - / 10mR / 3W / 1% / 75ppm/K / - / 2512 / SMD / -	Vishay
2	R178, R191	0R	RESC1609X50N	RES / STD / 0R / - / 0R / - / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R181, R192	32.4k	RESC1609X50N	RES / STD / 32.4k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R182, R193	16.2k	RESC1609X50N	RES / STD / 16.2k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R184, R195	6.65k	RESC1609X50N	RES / STD / 6.65k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R186, R197	20k	RESC1609X50N	RES / STD / 20k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay

1	T3	2.5mH	EE25-13-7_5644	Flyback Transfomer	Würth Elektronik
1	T7	2.5mH	EE25-13-7_5644	Flyback Transfomer	Würth Elektronik
2	U10, U12	ICE5QSAG	SOIC127P600X175-8N-6	Quasi-Resonant PWM Controller	Infineon Technologies
2	U11, U13	SFH617A-3X007T	SFH617A-3X007T	Optocoupler, Phototransistor Output, High Reliability, 5300 VRMS, 110 Â°C Rated	Vishay
2	U20, U21	IFX81481ELV	SOP65P600X170-15N	10A Synchronous DC/DC Step-Down Controller	Infineon Technologies
2	X2, X9	TSW-103-08-F-D-RA	CON-M-THT-TSW-103-08-F-D-RA	Through Hole .025 SQ Post header, 6 pins, Double Row, Right angle	Samtec
6	X6, X7, X8, X12, X13, X18	TSW-102-08-F-D-RA	HDRRA4W64P254_2X2_508X556X55 6B	2.54mm Pitch Header Strip, 4 pins, right angle, double row	Samtec
3	C66, C70, C71	1uF	CAPC1608X50N	CAP / CERA / 1uF / 10V / 10% / X5R (EIA) / -55¡ãC to 85¡ãC / 0603(1608) / SMD / -	MuRata
8	C1, C2, C11, C22, C23, C60, C69, C82	4.7uF	CAPC1608X90N	CAP / CERA / 4.7uF / 10V / 10% / X5R (EIA) / -55¡ãC to 85¡ãC / 0603(1608) / SMD / -	MuRata
35	C4, C5, C6, C7, C9, C10, C14, C15, C16, C17, C18, C19, C20, C21, C24, C26, C28, C29, C30, C31, C32, C33, C35, C54, C61, C64, C67, C68, C80, C81, C83, C87, C93, C96, C98	100nF	CAPC1608X90N	CAP / CERA / 100nF / 25V / 5% / X7R (EIA) / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
2	C12, C13	15pF	CAPC1608X90N	CAP / CERA / 15pF / 50V / 2% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
8	C25, C50, C51, C53, C63, C65, C92, C99	10nF	CAPC1608X90N	CAP / CERA / 10nF / 25V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -, CAP / CERA / 10nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
9	C27, C39, C46, C47, C52, C59, C86, C95, C97	1nF	CAPC1608X90N	CAP / CERA / 1nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
2	C57, C58	100pF	CAPC1608X90N	CAP / CERA / 100pF / 50V / 2% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
1	C3	22uF	CAPC2013X95N	CAP / CERA / 22uF / 10V / 20% / X5R (EIA) / -55¡ãC to	MuRata

				85¡ãC / 0805(2012) / SMD / -	
1	X4	61301021021	CON-M-THT-61301021021	Connector, 10Pins, 2.54mm Pitch, Board to Board	Wurth Elektronik
2	X2, X3	61302021021	CON-M-THT-61302021021	WR-PHD Angled Dual Pin Header, 20 Pins	Wurth Elektronik
1	CN3	691322110002	CON-TER-THT-691322110002	3.50mm Horizontal PCB Header WR-TBL	Wurth Elektronik
1	CN1	691322110003	CON-TER-THT-691322110003	3.50mm Horizontal PCB Header WR-TBL	Wurth Elektronik
1	CN2	TSW-103-08-F-S-NA	HDRRA3W64P254_1X3_762X302X302B	Through hole .025 SQ Post Header, 2.54mm pitch, 3 pin, right angle, single row	Samtec
2	L1, L2	300R	INDC2012X105N	IND / FERR / 300R / 600mA / 25% / -55¡ãC to 125¡ãC / 150mR / SMD / Inductor,Chip;2.00mm L X 1.25mm W X 1.05mm H / SMD / -	TDK Corporation
6	Q1, Q2, Q3, Q4, Q5, Q6	2N7002	INF-PG-SOT23_N-0	OptiMOS Small-Signal-Transistor	Infineon Technologies
1	U9	IFX25001TFV33	INF-PG-TO252-3-11_N	Low Dropout Voltage Regulator, 3.3 V Output	Infineon Technologies
3	D2, D6, D9	BAT54-04	INT_SOT23-3 - IFX	Silicon Schottky Diode	Infineon Technologies
8	LED1, LED2, LED3, LED4, LED5, LED6, LED8, LED9	Green	LEDSC160X80X80-2N	Surface Mount LED, Green, 570nm	OSRAM Opto Semiconductors
1	LED7	Red	LEDSC160X80X80-2N	Surface Mount LED, Super Red, 633nm	OSRAM Opto Semiconductors
1	U3	IFX_XMC4400-F100K512ABXUMA1	QFP50P1600X1600X160-101N	XMC4000 Family Microcontroller for Industrial Applications, ARM? Cortex?-M4, 32-bit processor core, Flash 512 Kbytes,SRAM 80 Kbytes (Temperature Range -40¡ãC to 125¡ãC)	Infineon Technologies
1	RT1	10k	RESC1608X95N-1	RES / NTC / 10k / 100mW / 1% / - / -40¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
24	R1, R3, R4, R6, R13, R14, R15, R16, R17, R31, R33, R63, R67, R69, R70, R77, R89, R100, R101, R102, R103, R106, R136, R137	22R	RESC1609X50N	RES / STD / 22R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
13	R2, R7, R8, R9, R19, R92, R96, R97, R98, R99, R120, R140, R141	0R	RESC1609X50N	RES / STD / 0R / - / 0R / - / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
27	R5, R21, R22, R24, R25, R26, R27, R28, R29, R30, R37,	1k	RESC1609X50N	RES / STD / 1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay

	R40, R45, R48, R71, R72, R73, R74, R75, R76, R78, R85, R86, R90, R91, R95, R114				
4	R11, R12, R87, R88	4.7k	RESC1609X50N	RES / STD / 4.7k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
23	R18, R20, R32, R34, R35, R38, R44, R47, R51, R79, R80, R81, R104, R108, R110, R111, R112, R130, R131, R132, R133, R134, R135	10k	RESC1609X50N	RES / STD / 10k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
19	R23, R53, R54, R55, R56, R57, R58, R59, R60, R61, R64, R65, R66, R68, R82, R84, R93, R94, R127	100R	RESC1609X50N	RES / STD / 100R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
4	R41, R43, R49, R52	100k	RESC1609X50N	RES / STD / 100k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R83, R139	2.2k	RESC1609X50N	RES / STD / 2.2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R118, R119	60.4R	RESC1609X50N	RES / STD / 60.4R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R138	5.1k	RESC1609X50N	RES / STD / 5.1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	D8	STPS1L60ZFY	SODFL3516X110N	Automotive low drop power Schottky rectifier, Temp Range (-40¡ãC to 175¡ãC)	STMicroelectronics
1	U1	ADuM3201ARZ-RL7	SOIC127P600X175-8N-1	Dual-Channel, Digital Isolators, Enhanced System-Level ESD Reliability	Analog Devices
1	U2	TLE9251VSJ	SOIC127P600X175-8N-3	High Speed CAN Transceiver	Infineon Technologies
1	U5	FM25040B-G	SOIC127P602X173-8N	4-Kbit (512 ¡Á 8) Serial (SPI) F-RAM, Temp Range (-40¡ãC to +85¡ãC)	Cypress Semiconductor
1	U4	OPTIGA TRUST X SLS 32AIA	SON50P300X300X60-11N-V	OPTIGA? Trust X, 5.5V (VCC Max), Upto 10KB User Memory	Infineon Technologies
1	U7	REF3318AIDBZR	SOT95P237X112-3N-1	1.8-V, 30-ppm/¡ãC drift, 3.9-¦ÌA, 3-pin	Texas Instruments

				SOT-23 voltage reference	
1	U8	REF3333AIDBZR	SOT95P237X112-3N-1	3.9-|ÌA SOT-23-3 30-ppm/¡ãC Drift Voltage Reference	Texas Instruments
2	D5, D7	BAT54-04	SOT95P240X110-3N-1	Silicon Schottky Diode	Infineon Technologies
3	TP1, TP2, TP3	IFX-Testpad-1.27mm	testpad_1.27mm	Testpad, SMD, 1.27 mm	Infineon Technologies
1	MD1	USR-C216	USR-C216	Low Power IoT Wifi Module	-
1	X1	12MHz	XTAL-SMD-CX3225CA	SMD Crystal, 12MHz, Temperature Range (-40¡ãC to 125¡ãC)	Kyocera
8	C12, C15, C32, C35, C48, C49, C60, C61	220nF	CAPC2013X140N	CAP / CERA / 220nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
8	C16, C17, C18, C19, C41, C50, C51, C57	3.3uF	CAPRR2750W80L3150T1800H2750B	CAP / - / 3.3uF / 1.1kV / 5% / MKP (Metallized Polypropylene) / -40Â°C to 105Â°C / 27.50mm C X 0.80mm W 31.50mm L X 18.00mm T X 27.50mm H / - / -	TDK Corporation
4	C36, C63, C66, C145	1nF	0603	CAP / CERA / 1nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
13	C39, C68, C82, C83, C110, C111, C127, C128, C159, C160, C178, C180, C246	10nF	CAPC1608X90N	CAP / CERA / 10nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -, CAP / CERA / 10nF / 25V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
3	C62, C65, C84	6.8nF	0603	Chip Monolithic Ceramic Capacitor, CAP / CERA / 6.8nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
2	C95, C156	10pF	CAPC2013X100N	CAP / CERA / 10pF / 200V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	MuRata
4	C113, C114, C119, C120	1nF	1206	CAP / CERA / 1nF / 630V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
5	C115, C117, C121, C123, C135	100uF	CAPMP7343X310N-1	Polymer Surface Mount Chip Capacitor Molded Case, High Performance Type, CAP / ELCO / 100uF / 25V / 20% / Tantalumelectrolytic / -55¡ãC to 105¡ãC / 7.30mm L X 4.30mm W X 3.10mm H / SMD / -	Vishay
9	C116, C118, C122, C124, C139, C140, C147, C148, C149	10uF	1210	CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -, CAP / CERA / 10uF / 50V /	TDK Corporation

				10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -, CAP / - / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -	
2	C126, C136	220nF	1206	CAP / CERA / 220nF / 100V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
6	C129, C130, C131, C137, C138, C152	330uF	CAPAE660X800N-3	CAP / ELCO / 330uF / 16V / 20% / Aluminiumelectrolytic / -55¡ãC to 105¡ãC / 6.60mm L X 6.60mm W X 8.00mm H / SMD / -	Panasonic
3	C132, C133, C134	4.7uF	0805	CAP / CERA / 4.7uF / 25V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
2	C141, C142	2.2uF	1206	CAP / CERA / 2.2uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
3	C143, C144, C146	1uF	1206	CAP / - / 1uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -	TDK Corporation
1	C150	22nF	0603	CAP / CERA / 22nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
1	C151	4.7nF	0603	CAP / - / 4.7nF / 50V / 5% / C0G (EIA) / NP0 / -55Â°C to 125Â°C / 0603(1608) / SMD / -	TDK Corporation
16	D1, D2, D3, D4, D5, D6, D9, D10, D17, D18, D19, D20, D23, D24, D25, D26	BAT165	SOD2513X110N	Medium Power AF Schottky Diode	Infineon Technologies
8	D7, D8, D11, D12, D29, D30, D31, D32	BAS3005A-02V	SODFL1608X59N	Low VF Schottky Diode	Infineon Technologies
6	D13, D14, D15, D16, D21, D22	MBRS1100T3G	DIOM5436X247N	Schottky Power Rectifier	ON Semiconductor
1	D27	MBRA340T3G	DIOM5226X220N	Schottky Barrier Rectifier 3.0A /40V	ON Semiconductor
1	D34	Orange	LED-SMD-LO L29K-XXXX-24	Surface Mount LED, Orange, 606nm	OSRAM Opto Semiconductors
1	G1	IFX91041EJV50	SOIC127P600X170-9N-1	1.8A DC/DC Step-Down Voltage Regulator - 5V Output Voltage	Infineon Technologies
1	G2	IFX30081LD V33	SON50P330X330X110-11N-V	3.3V, 50mA Linear Voltage Regulator with Ultra Low Quiescent Current,	Infineon Technologies
1	G3	IFX25001TFV33	INF-PG-TO252-3-11_N	Low Dropout Voltage Regulator, 3.3 V Output	Infineon Technologies
1	G4	TLS202B1MBV33	PG-SCT595	Fixed Linear Voltage Post Regulator, 3.3V	Infineon Technologies
2	HS1, HS2	SK 489 100 AL	HS SK 489 100	Extruded Heatsink for Lock-in Retaining Spring, PCB	Fischer Elektronik

				mounting, 100mm L X 29.44mm W X 45mm H, Raw degreased aluminum	
1	L1	47uH	INDP7373X41N	IND / STD / 47uH / 1.5A / 20% / -40Â°C to 125Â°C / 127mR / SMD / 7.3mmx7.3mmx4.1mm / SMD / -	Coilcraft
1	L4	36uH	PQ4044	Resonant Inductor	Sunlord
1	L5	22uH	PQ4044	Resonant Inductor	Sunlord
8	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	IMZ120R045M1	INF-PG-TO247-4	CoolSiC 1200 V SiC Trench MOSFET	Infineon Technologies
24	R1, R2, R5, R12, R15, R16, R17, R18, R21, R28, R33, R34, R47, R48, R49, R54, R57, R58, R59, R62, R67, R68, R69, R70	33k	RESC3216X60N	Standard Thick Film Chip Resistor	Vishay
8	R3, R4, R19, R20, R90, R91, R92, R93	2.2k	RESC3216X60N	RES / STD / 2.2k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
8	R6, R7, R22, R23, R50, R51, R60, R61	10R	RESC3216X65N-1	RES / STD / 10R / 500mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206(3216) / SMD / -	Vishay
8	R8, R9, R24, R25, R52, R53, R63, R64	2.2R	RESC3216X65N-1	RES / STD / 2.2R / 500mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
20	R10, R11, R26, R27, R44, R45,R55, R56, R65, R66, R86, R102, R110, R129, R130, R139, R147, R153, R154, R199	100R	RESC1609X50N	RES / STD / 100R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
8	R13, R14, R29, R30, R117, R118, R119, R120	4.7k	RESC3216X60N	RES / STD / 4.7k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R31, R32	22R	RESC3216X60N	RES / STD / 22R / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R35, R36	3mR	RESC6432X90N	High Power Current Sense Chip Resistor	Bourns
24	R37, R73, R74, R75, R76, R77, R78, R81, R87, R89, R94, R98, R99, R100, R103, R104, R106, R107, R132, R133,	137k	RESC3216X60N	RES / STD / 137k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay

	R134, R135, R136, R137				
2	R38, R39	8.45k	RESC1609X50N	RES / STD / 8.45k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
1	R40	1.74k	RESC1609X50N	RES / STD / 1.74k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
6	R41, R97, R105, R109, R203, R204	0R	RESC1609X50N	RES / STD / 0R / - / 0R / - / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
26	R42, R43, R84, R85, R95, R111, R112, R113, R114, R121, R124, R125, R128, R138, R140, R141, R144, R148, R149, R152, R155, R156, R157, R179, R180, R201	1k	RESC1609X50N	RES / STD / 1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -, RES / STD / 1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R46, R115	2.2k	RESC1609X50N	RES / STD / 2.2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R71, R72	16.5R	RESC3216X60N	RES / STD / 16.5R / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
2	R79, R80	4.7k	RESC1609X50N	RES / STD / 4.7k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R82	1k	RESC1609X50N	RES / STD / 1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R83	1.5k	RESC1609X50N	RES / STD / 1.5k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R88	5.1k	RESC1609X50N	RES / STD / 5.1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R96, R108	2.21k	RESC1609X50N	RES / STD / 2.21k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R101	10k	RESC1608X95N-1	RES / NTC / 10k / 100mW / 1% / - / - 40¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
2	R116, R131	133k	RESC1609X50N	RES / STD / 133k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R122, R126	680R	RESC1609X50N	RES / STD / 680R / 100mW / 1% / 100ppm/K / -55¡ãC to	Vishay

				155¡ãC / 0603 / SMD / -	
2	R142, R143	10k	RESC1609X50N	RES / STD / 10k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R145, R150	4.42k	RESC1609X50N	RES / STD / 4.42k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R158, R159	61.9k	RESC1609X50N	RES / STD / 61.9k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
4	R160, R161, R166, R167	2.2R	RESC3216X60N	Standard Thick Film Chip Resistor	Vishay
8	R162, R163, R164, R165, R168, R169, R170, R171	10k	RESC3216X60N	RES / STD / 10k / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
1	R172	22k	RESC1609X50N	RES / STD / 22k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R174, R175	15k	RESC1609X50N	Standard Thick Film Chip Resistor, RES / STD / 15k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
1	R200	2k	RESC1609X50N	RES / STD / 2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R202	5.1k	RESC3216X60N	RES / STD / 5.1k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
1	S1	CAS-120A1	CAS-120A1	Single-pole changeover slide switch	NIDEC COPAL ELECTRONICS, Inc.
2	T1, T6	80uH	TRANSFORMER PQ6558	LLC Transformers	Sunlord
4	T2, T3, T4, T5	410uH	EP7_4436	Transformer 8-Terminal EXT, SMD, Horizontal, EP Style Bobbins, EP7	Würth Elektronik
2	TR1, TR2	PE-67200NL	TR-THT-PE-67200NL	Current Sense Transformer, 4250VRMS primary to secondary breakdown voltage	Pulse Electronics
8	U1, U2, U3, U4, U5, U6, U7, U8	1EDC20I12AH	SOIC127P1030X265-8N-V	Single channel IGBT gate driver IC Up to 10 A typical peak current , Â±2.0 A Output current configuration	Infineon Technologies
1	U9	TLI4971	INF-PG-TISON-8	High Precision Coreless Current Sensor	Infineon Technologies
7	U10, U13, U15, U16, U17, U18, U19	LM397MF/NOPB	SOT95P280X145-5N-2-V	This Device is a single voltage comparator	Texas Instruments
1	U11	AMC1302DWVR	SOIC127P1150X280-8N	Reinforced Isolated Amplifier With High CMTI Input Voltage Range of Â±50 mV,	Texas Instruments

				and High Bandwidth of 280 kHz	
1	U12	ISO7720FDWVR	SOIC127P1150X280-8N	High-Speed, Robust EMC, Reinforced and Basic Dual-Channel Digital Isolator	Texas Instruments
1	U14	AMC1311BDWV	SOIC127P1150X280-8N	High-Impedance, 2-V Input, Reinforced Isolated Amplifier	Texas Instruments
1	U22	UCC12050DVE	SOIC127P1030X265-16N-1	High-Efficiency, Low-EMI, 5-kVRMS Reinforced Isolation DC-DC Converter	Texas Instruments
4	X1, X2, X21, X26	74655095R	CON-TER-THT-74655095R	REDCUBE THR with internal thru hole thread	Wurth Elektronik
3	X5, X6, X7	505575-0471	CON-M-SMD-505575-0471	Micro-Lock Plus Wire-to-Board Connector System	Molex
2	X8, X9	662302131822	CON-M-SMD-662302131822	CONNECTOR HEADER SMD 4POS 1.25MM	Wurth Elektronik
8	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8	2.4V	SOD3715X145N	Zener-Diode, 2.4V	Diodes Incorporated
8	C12, C15, C32, C35, C48, C49, C60, C61	220nF	CAPC2013X140N	CAP / CERA / 220nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
8	C16, C17, C18, C19, C41, C50, C51, C57	3.3uF	CAPRR2750W80L3150T1800H2750B	CAP / - / 3.3uF / 1.1kV / 5% / MKP (Metallized Polypropylene) / -40Â°C to 105Â°C / 27.50mm C X 0.80mm W 31.50mm L X 18.00mm T X 27.50mm H / - / -	TDK Corporation
4	C36, C63, C66, C145	1nF	0603	CAP / CERA / 1nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
13	C39, C68, C82, C83, C110, C111, C127, C128, C159, C160, C178, C180, C246	10nF	CAPC1608X90N	CAP / CERA / 10nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -, CAP / CERA / 10nF / 25V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
3	C62, C65, C84	6.8nF	0603	Chip Monolithic Ceramic Capacitor, CAP / CERA / 6.8nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
2	C95, C156	10pF	CAPC2013X100N	CAP / CERA / 10pF / 200V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	MuRata
4	C113, C114, C119, C120	1nF	1206	CAP / CERA / 1nF / 630V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
5	C115, C117, C121, C123, C135	100uF	CAPMP7343X310N-1	Polymer Surface Mount Chip Capacitor Molded Case, High Performance Type, CAP / ELCO / 100uF / 25V / 20% /	Vishay

				Tantalumelectrolytic / -55¡ãC to 105¡ãC / 7.30mm L X 4.30mm W X 3.10mm H / SMD / -	
9	C116, C118, C122, C124, C139, C140, C147, C148, C149	10uF	1210	CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -, CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -, CAP / - / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -	TDK Corporation
2	C126, C136	220nF	1206	CAP / CERA / 220nF / 100V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
6	C129, C130, C131, C137, C138, C152	330uF	CAPAE660X800N-3	CAP / ELCO / 330uF / 16V / 20% / Aluminiumelectrolytic / -55¡ãC to 105¡ãC / 6.60mm L X 6.60mm W X 8.00mm H / SMD / -	Panasonic
3	C132, C133, C134	4.7uF	0805	CAP / CERA / 4.7uF / 25V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
2	C141, C142	2.2uF	1206	CAP / CERA / 2.2uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
3	C143, C144, C146	1uF	1206	CAP / - / 1uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -	TDK Corporation
1	C150	22nF	0603	CAP / CERA / 22nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
1	C151	4.7nF	0603	CAP / - / 4.7nF / 50V / 5% / C0G (EIA) / NP0 / -55Â°C to 125Â°C / 0603(1608) / SMD / -	TDK Corporation
16	D1, D2, D3, D4, D5, D6, D9, D10, D17, D18, D19, D20, D23, D24, D25, D26	BAT165	SOD2513X110N	Medium Power AF Schottky Diode	Infineon Technologies
8	D7, D8, D11, D12, D29, D30, D31, D32	BAS3005A-02V	SODFL1608X59N	Low VF Schottky Diode	Infineon Technologies
6	D13, D14, D15, D16, D21, D22	MBRS1100T3G	DIOM5436X247N	Schottky Power Rectifier	ON Semiconductor
1	D27	MBRA340T3G	DIOM5226X220N	Schottky Barrier Rectifier 3.0A /40V	ON Semiconductor
1	D34	Orange	LED-SMD-LO L29K-XXXX-24	Surface Mount LED, Orange, 606nm	OSRAM Opto Semiconductors
1	G1	IFX91041EJV50	SOIC127P600X170-9N-1	1.8A DC/DC Step-Down Voltage Regulator - 5V Output Voltage	Infineon Technologies

1	G2	IFX30081LD V33	SON50P330X330X110-11N-V	3.3V, 50mA Linear Voltage Regulator with Ultra Low Quiescent Current,	Infineon Technologies
1	G3	IFX25001TFV33	INF-PG-TO252-3-11_N	Low Dropout Voltage Regulator, 3.3 V Output	Infineon Technologies
1	G4	TLS202B1MBV33	PG-SCT595	Fixed Linear Voltage Post Regulator, 3.3V	Infineon Technologies
2	HS1, HS2	SK 489 100 AL	HS SK 489 100	Extruded Heatsink for Lock-in Retaining Spring, PCB mounting, 100mm L X 29.44mm W X 45mm H, Raw degreased aluminum	Fischer Elektronik
1	L1	47uH	INDP7373X41N	IND / STD / 47uH / 1.5A / 20% / -40Â°C to 125Â°C / 127mR / SMD / 7.3mmx7.3mmx4.1mm / SMD / -	Coilcraft
1	L4	36uH	PQ4044	Resonant Inductor	Sunlord
1	L5	22uH	PQ4044	Resonant Inductor	Sunlord
8	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	IMZ120R045M1	INF-PG-TO247-4	CoolSiC 1200 V SiC Trench MOSFET	Infineon Technologies
24	R1, R2, R5, R12, R15, R16, R17, R18, R21, R28, R33, R34, R47, R48, R49, R54, R57, R58, R59, R62, R67, R68, R69, R70	33k	RESC3216X60N	Standard Thick Film Chip Resistor	Vishay
8	R3, R4, R19, R20, R90, R91, R92, R93	2.2k	RESC3216X60N	RES / STD / 2.2k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
8	R6, R7, R22, R23, R50, R51, R60, R61	10R	RESC3216X65N-1	RES / STD / 10R / 500mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206(3216) / SMD / -	Vishay
8	R8, R9, R24, R25, R52, R53, R63, R64	2.2R	RESC3216X65N-1	RES / STD / 2.2R / 500mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
20	R10, R11, R26, R27, R44, R45,R55, R56, R65, R66, R86, R102, R110, R129, R130, R139, R147, R153, R154, R199	100R	RESC1609X50N	RES / STD / 100R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
8	R13, R14, R29, R30, R117, R118, R119, R120	4.7k	RESC3216X60N	RES / STD / 4.7k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R31, R32	22R	RESC3216X60N	RES / STD / 22R / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay

2	R35, R36	3mR	RESC6432X90N	High Power Current Sense Chip Resistor	Bourns
24	R37, R73, R74, R75, R76, R77, R78, R81, R87, R89, R94, R98, R99, R100, R103, R104, R106, R107, R132, R133, R134, R135, R136, R137	137k	RESC3216X60N	RES / STD / 137k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
2	R38, R39	8.45k	RESC1609X50N	RES / STD / 8.45k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
1	R40	1.74k	RESC1609X50N	RES / STD / 1.74k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
6	R41, R97, R105, R109, R203, R204	0R	RESC1609X50N	RES / STD / 0R / - / 0R / - / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
26	R42, R43, R84, R85, R95, R111, R112, R113, R114, R121, R124, R125, R128, R138, R140, R141, R144, R148, R149, R152, R155, R156, R157, R179, R180, R201	1k	RESC1609X50N	RES / STD / 1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -, RES / STD / 1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R46, R115	2.2k	RESC1609X50N	RES / STD / 2.2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R71, R72	16.5R	RESC3216X60N	RES / STD / 16.5R / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
2	R79, R80	4.7k	RESC1609X50N	RES / STD / 4.7k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R82	1k	RESC1609X50N	RES / STD / 1k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R83	1.5k	RESC1609X50N	RES / STD / 1.5k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R88	5.1k	RESC1609X50N	RES / STD / 5.1k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R96, R108	2.21k	RESC1609X50N	RES / STD / 2.21k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay

1	R101	10k	RESC1608X95N-1	RES / NTC / 10k / 100mW / 1% / - / - 40¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
2	R116, R131	133k	RESC1609X50N	RES / STD / 133k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R122, R126	680R	RESC1609X50N	RES / STD / 680R / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R142, R143	10k	RESC1609X50N	RES / STD / 10k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R145, R150	4.42k	RESC1609X50N	RES / STD / 4.42k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
2	R158, R159	61.9k	RESC1609X50N	RES / STD / 61.9k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
4	R160, R161, R166, R167	2.2R	RESC3216X60N	Standard Thick Film Chip Resistor	Vishay
8	R162, R163, R164, R165, R168, R169, R170, R171	10k	RESC3216X60N	RES / STD / 10k / 250mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 1206 / SMD / -	Vishay
1	R172	22k	RESC1609X50N	RES / STD / 22k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
2	R174, R175	15k	RESC1609X50N	Standard Thick Film Chip Resistor, RES / STD / 15k / 100mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 0603 / SMD / -	Vishay
1	R200	2k	RESC1609X50N	RES / STD / 2k / 100mW / 1% / 100ppm/K / -55¡ãC to 155¡ãC / 0603 / SMD / -	Vishay
1	R202	5.1k	RESC3216X60N	RES / STD / 5.1k / 250mW / 1% / 100ppm/K / -55Â°C to 155Â°C / 1206 / SMD / -	Vishay
1	S1	CAS-120A1	CAS-120A1	Single-pole changeover slide switch	NIDEC COPAL ELECTRONICS, Inc.
2	T1, T6	80uH	TRANSFORMER PQ6558	LLC Transformers	Sunlord
4	T2, T3, T4, T5	410uH	EP7_4436	Transformer 8-Terminal EXT, SMD, Horizontal, EP Style Bobbins, EP7	Würth Elektronik
2	TR1, TR2	PE-67200NL	TR-THT-PE-67200NL	Current Sense Transformer, 4250VRMS primary to secondary breakdown voltage	Pulse Electronics
8	U1, U2, U3, U4, U5, U6, U7, U8	1EDC20I12AH	SOIC127P1030X265-8N-V	Single channel IGBT gate driver IC Up to 10 A typical peak current , Â±2.0 A	Infineon Technologies

				Output current configuration	
1	U9	TLI4971	INF-PG-TISON-8	High Precision Coreless Current Sensor	Infineon Technologies
7	U10, U13, U15, U16, U17, U18, U19	LM397MF/NOPB	SOT95P280X145-5N-2-V	This Device is a single voltage comparator	Texas Instruments
1	U11	AMC1302DWVR	SOIC127P1150X280-8N	Reinforced Isolated Amplifier With High CMTI Input Voltage Range of Â±50 mV, and High Bandwidth of 280 kHz	Texas Instruments
1	U12	ISO7720FDWVR	SOIC127P1150X280-8N	High-Speed, Robust EMC, Reinforced and Basic Dual-Channel Digital Isolator	Texas Instruments
1	U14	AMC1311BDWV	SOIC127P1150X280-8N	High-Impedance, 2-V Input, Reinforced Isolated Amplifier	Texas Instruments
1	U22	UCC12050DVE	SOIC127P1030X265-16N-1	High-Efficiency, Low-EMI, 5-kVRMS Reinforced Isolation DC-DC Converter	Texas Instruments
4	X1, X2, X21, X26	74655095R	CON-TER-THT-74655095R	REDCUBE THR with internal thru hole thread	Wurth Elektronik
3	X5, X6, X7	505575-0471	CON-M-SMD-505575-0471	Micro-Lock Plus Wire-to-Board Connector System	Molex
2	X8, X9	662302131822	CON-M-SMD-662302131822	CONNECTOR HEADER SMD 4POS 1.25MM	Wurth Elektronik
8	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8	2.4V	SOD3715X145N	Zener-Diode, 2.4V	Diodes Incorporated
8	C12, C15, C32, C35, C48, C49, C60, C61	220nF	CAPC2013X140N	CAP / CERA / 220nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
8	C16, C17, C18, C19, C41, C50, C51, C57	3.3uF	CAPRR2750W80L3150T1800H2750B	CAP / - / 3.3uF / 1.1kV / 5% / MKP (Metallized Polypropylene) / -40Â°C to 105Â°C / 27.50mm C X 0.80mm W 31.50mm L X 18.00mm T X 27.50mm H / - / -	TDK Corporation
4	C36, C63, C66, C145	1nF	0603	CAP / CERA / 1nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
13	C39, C68, C82, C83, C110, C111, C127, C128, C159, C160, C178, C180, C246	10nF	CAPC1608X90N	CAP / CERA / 10nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -, CAP / CERA / 10nF / 25V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	MuRata
3	C62, C65, C84	6.8nF	0603	Chip Monolithic Ceramic Capacitor, CAP / CERA / 6.8nF / 50V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation
2	C95, C156	10pF	CAPC2013X100N	CAP / CERA / 10pF / 200V / 5% / C0G (EIA) / NP0 / -55¡ãC	MuRata

				to 125¡ãC / 0805(2012) / SMD / -	
4	C113, C114, C119, C120	1nF	1206	CAP / CERA / 1nF / 630V / 5% / C0G (EIA) / NP0 / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
5	C115, C117, C121, C123, C135	100uF	CAPMP7343X310N-1	Polymer Surface Mount Chip Capacitor Molded Case, High Performance Type, CAP / ELCO / 100uF / 25V / 20% / Tantalumelectrolytic / -55¡ãC to 105¡ãC / 7.30mm L X 4.30mm W X 3.10mm H / SMD / -	Vishay
9	C116, C118, C122, C124, C139, C140, C147, C148, C149	10uF	1210	CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1210(3225) / SMD / -, CAP / CERA / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -, CAP / - / 10uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1210(3225) / SMD / -	TDK Corporation
2	C126, C136	220nF	1206	CAP / CERA / 220nF / 100V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
6	C129, C130, C131, C137, C138, C152	330uF	CAPAE660X800N-3	CAP / ELCO / 330uF / 16V / 20% / Aluminiumelectrolytic / -55¡ãC to 105¡ãC / 6.60mm L X 6.60mm W X 8.00mm H / SMD / -	Panasonic
3	C132, C133, C134	4.7uF	0805	CAP / CERA / 4.7uF / 25V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0805(2012) / SMD / -	TDK Corporation
2	C141, C142	2.2uF	1206	CAP / CERA / 2.2uF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 1206(3216) / SMD / -	TDK Corporation
3	C143, C144, C146	1uF	1206	CAP / - / 1uF / 50V / 10% / X7R (EIA) / -55Â°C to 125Â°C / 1206(3216) / SMD / -	TDK Corporation
1	C150	22nF	0603	CAP / CERA / 22nF / 50V / 10% / X7R (EIA) / -55¡ãC to 125¡ãC / 0603(1608) / SMD / -	TDK Corporation

4 References and appendices

4.1 Abbreviations and definitions

Table 5 Abbreviations

Abbreviation	Meaning
CE	Conformité Européenne
EMI	Electromagnetic interference
UL	Underwriters Laboratories

4.2 References

[1] "800 W ZVS phase-shift full-bridge evaluation board. Using 600 V CoolMOS™ CFD7 and digital control by XMC4200", AN_201709_PL52_027

[2] "1400 W ZVS phase-shift full-bridge evaluation board. Using 600 V CoolMOS™ CFD7 and digital control by XMC4200", AN_201711_PL52_003

[3] Jared Huntington, "6 W bias supply. Using the new 800 V CoolMOS™ P7, ICE5QSAG QR flyback controller, and snubberless flyback for improved auxiliary power-supply efficiency and form factor", AN_201709_PL52_030

[4] Design of CLLC Resonant Converters for the Hybrid AC/DC Microgrid Applications

[5] IMBF170R1K0M1 datasheet, 1700 V CoolSiC™ MOSFET

[6] UCC28600 datasheet, 8-Pin Quasi-Resonant flyback Green-Mode Controller

[7] Gate resistor for power devices, Infineon Technologies, application note AN2015-06

Revision history

Document version	Date of release	Description of changes
1.0	2020-11-03	First version
1.1	2021-03-03	Updated layout,schematic and bill of materials

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