# 6-kW high-frequency and high-density HVIBC user guide

## REF_6KW_800V_12V_IBC

## About this document

### Scope and purpose

This user guide describes the REF_6KW_800V_12V_IBC reference board and provides instructions for its setup and evaluation. The board is a 6-kW, high-frequency, high-power-density isolated intermediate bus converter (IBC) intended for data center and artificial intelligence (AI) server power systems. It uses CoolGaN™ Transistor 650 V G5 devices on the primary side and OptiMOS™ 7 power MOSFETs on the secondary side.

The board accepts a nominal 800 V DC input across its HV+ and HV− terminals. The terminals can be supplied from either an 800 V/0 V or a +400 V/−400 V system; no midpoint connection to the board is required

The board measures 130 mm × 40 mm × 8 mm (L × W × H). Its reported peak efficiency is 98.2%, and its reported efficiency at a 6-kW output is approximately 97.1%.

### Intended audience

This guide is intended for power electronics engineers, qualified laboratory personnel, and system developers who set up, evaluate, or integrate high-voltage power converters.

### Keypoints

- Two-terminal high-voltage input (HV+ and HV−), with a nominal voltage of 800 V DC
- Operation with external terminal potentials of either 800 V/0 V or +400 V/−400 V; no external neutral or midpoint connection to the board
- Nominal, unregulated 12-V output; maximum output power of 6 kW
- Stacked half-bridge LLC topology with an input-series, output-parallel (ISOP) architecture
- CoolGaN™ Transistor 650 V G5 devices on the primary side and OptiMOS™ 7 power MOSFETs on the secondary side
- PCB-integrated planar transformer with a matrix-transformer-based winding structure
- Peak efficiency of 98.2% and efficiency of approximately 97.1% at a 6-kW output load

### Target applications

- Data center power solutions
- Server rack power management

### Reference Board

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

## Safety precautions

*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.* |

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# 1 Introduction

The increasing power demand of AI accelerators is driving the adoption of higher-voltage power distribution in data centers. In these systems, high-voltage intermediate bus converters (HVIBCs) convert the distribution voltage to an intermediate bus voltage for downstream point-of-load converters. The REF_6KW_800V_12V_IBC reference board demonstrates isolated conversion from an 800 V DC input to a nominal 12 V output.

## 1.1 Reference board overview

The REF_6KW_800V_12V_IBC is a high-frequency, 6-kW isolated IBC reference board for data center and AI server power systems. It accepts a nominal 800 V DC input across its HV+ and HV− terminals and provides a nominal, unregulated 12 V output at up to 500 A. With respect to an external voltage reference, the input terminals may be at 800 V and 0 V or at +400 V and −400 V. The board does not require a midpoint connection. The primary-side power stage uses CoolGaN™ Transistor 650 V G5 devices, and the secondary-side synchronous rectifiers use OptiMOS™ 7 power MOSFETs. The reported peak efficiency is 98.2%, and the efficiency at a 6-kW output load is approximately 97.1%.

The converter adopts a stacked half-bridge LLC topology with an ISOP architecture. The topology employs two identical LLC stages operating with a 90-degree phase shift to achieve interleaved operation, minimizing output current ripple, improving current sharing, and reducing component stress. The converter is designed for open-loop operation, which is commonly adopted in IBC applications to maximize efficiency and power density.

Figure 1 shows the reference board dimensions and its installation on the evaluation carrier board. The converter board measures 130 mm × 40 mm × 8 mm (L × W × H). At a 6-kW output, its power density exceeds 2000 W/in$^3$ when calculated from these board dimensions; this figure excludes the carrier board, external control card, and heatsink. The converter board incorporates the primary-side switches, secondary-side synchronous rectifiers, gate drivers, magnetic components, and supporting circuitry.

The power stage uses a planar transformer with a custom EI core and windings formed in the PCB copper layers. The transformer provides the magnetizing and leakage inductances required by the LLC stages, eliminating the need for separate resonant inductors. The primary-side CoolGaN™ devices and secondary-side OptiMOS™ 7 power MOSFET synchronous rectifiers use top-side-cooled packages, providing a thermal path to an external heatsink.

The reference board is intended for use with the external KIT_PSC3M5_CC1 Digital Power Control Card. The control card generates the PWM signals for the primary- and secondary-side gate drivers and provides the 3.3 V supply rail required by the isolated driver interface.

*Note:* *See KIT_PSC3M5_CC1 user guide for detailed information regarding the KIT_PSC3M5_CC1 Digital Power Control Card, including hardware architecture, firmware implementation.*

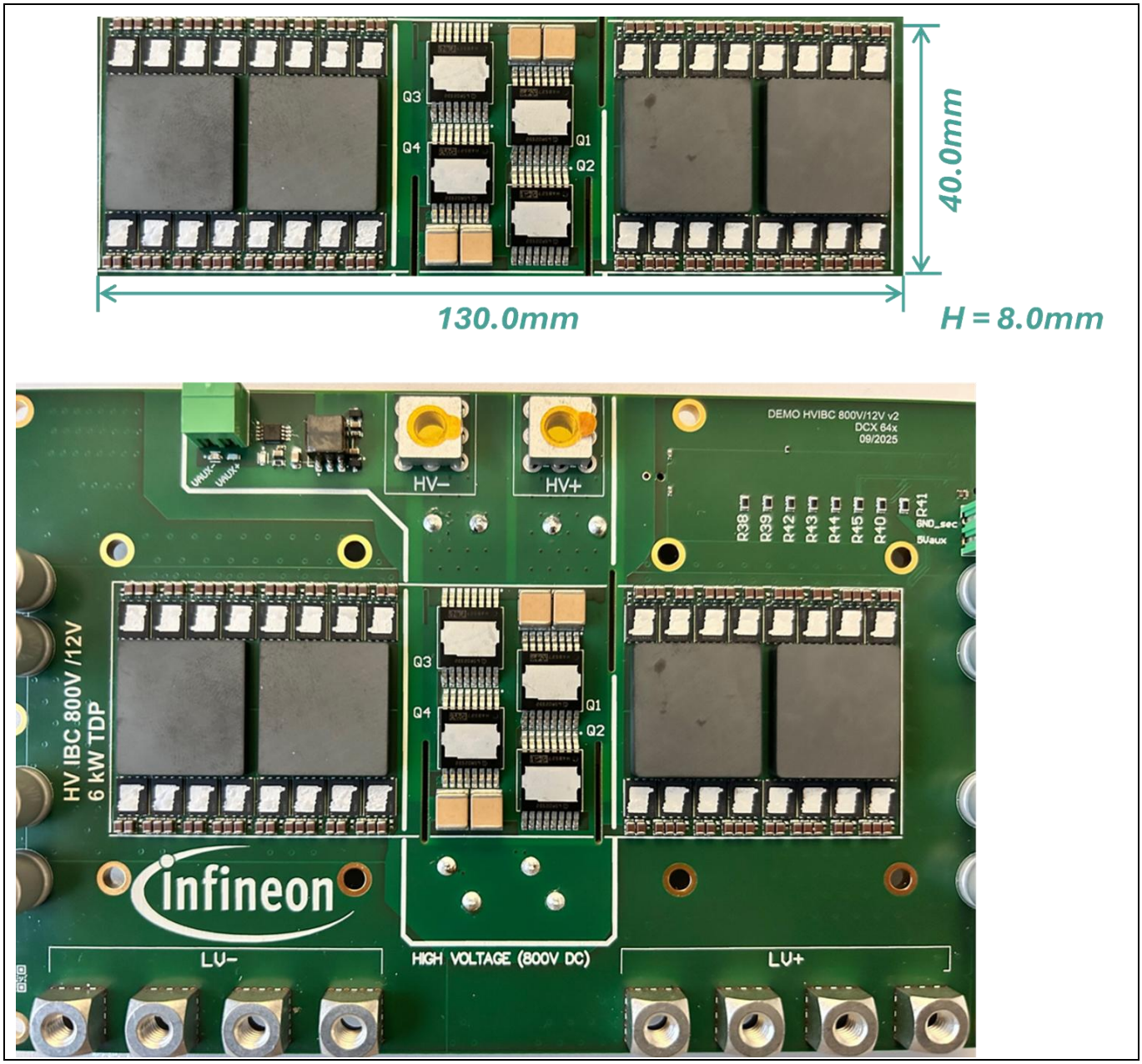



**Figure 1** **REF_6KW_800V_12V_IBC reference board dimensions and installation on the evaluation carrier board**

## 1.2 System architecture

Figure 2 shows a simplified schematic of the REF_6KW_800V_12V_IBC. The converter uses two stacked half-bridge LLC stages to convert a nominal 800 V DC input across HV+ and HV− to a nominal, unregulated 12 V output. The input is divided across the two stages by series-connected capacitors. Under nominal conditions, each stage operates across approximately 400 V. The midpoint between the stages is generated within the board; no external midpoint connection is required. The secondary-side rectifiers of the two stages are connected in parallel at the output.

Each LLC stage uses CoolGaN™ Transistor 650 V G5 devices in its primary-side half-bridge. On the secondary side, each stage has eight parallel center-tapped synchronous-rectifier (CTSR) branches implemented with OptiMOS™ 7 power MOSFETs. The parallel branches distribute the output current among the rectifiers. The LLC transformers provide galvanic isolation between the input and output power circuits.

The primary-side switches are driven by dual-channel isolated gate drivers EiceDRIVER™ 2EDR7259X. The secondary-side synchronous rectifiers (SR) are driven by EiceDRIVER™ 2EDN7534G gate drivers. The precise isolation boundary of the primary-side gate-drive circuit should be identified in the gate-driver description rather than inferred from this simplified schematic.

External bias supplies are required for the gate-drive and control circuits. An external 9 V supply powers the EiceDRIVER™ 2EP130R transformer driver, which generates two isolated 9 V supplies for the primary-side gate drivers through an isolation transformer. An external 5.7 V supply powers the secondary-side gate drivers. The external KIT_PSC3M5_CC1 Digital Power Control Card requires a separate supply; it generates PWM signals and provides a 3.3 V supply rail to the driver interfaces and associated control circuitry.

The REF_6KW_800V_12V_IBC is intended for evaluation and development only. The present hardware and firmware do not implement overcurrent protection (OCP), overvoltage protection (OVP), undervoltage protection (UVP), short-circuit protection (SCP), or thermal protection, or thermal derating. Users must implement the protection measures required for their test setup and system.

The key Infineon components used in the REF_6KW_800V_12V_IBC are as follows:

- **Primary-side switches:** IGLT65R025D2 CoolGaN™ Transistor 650 V G5 (30 mΩ, PG -HDSOP -16) [1]
- **Primary-side HB drivers:** EiceDRIVER™ 2EDR7259X [2]
- **Secondary-side SR switches:** OptiMOS™ 7 power MOSFET 40 V ISCH69N04LM7SC, 0.69 mΩ, PG-WSON-8 [3]
- **Secondary-side SR driver:** EiceDRIVER™ 2EDN7534G [4]
- **Auxiliary power driver:** EiceDRIVER™ 2EP130R transformer driver IC [5]
- **Digital power control card:** KIT_PSC3M5_CC1 [7]

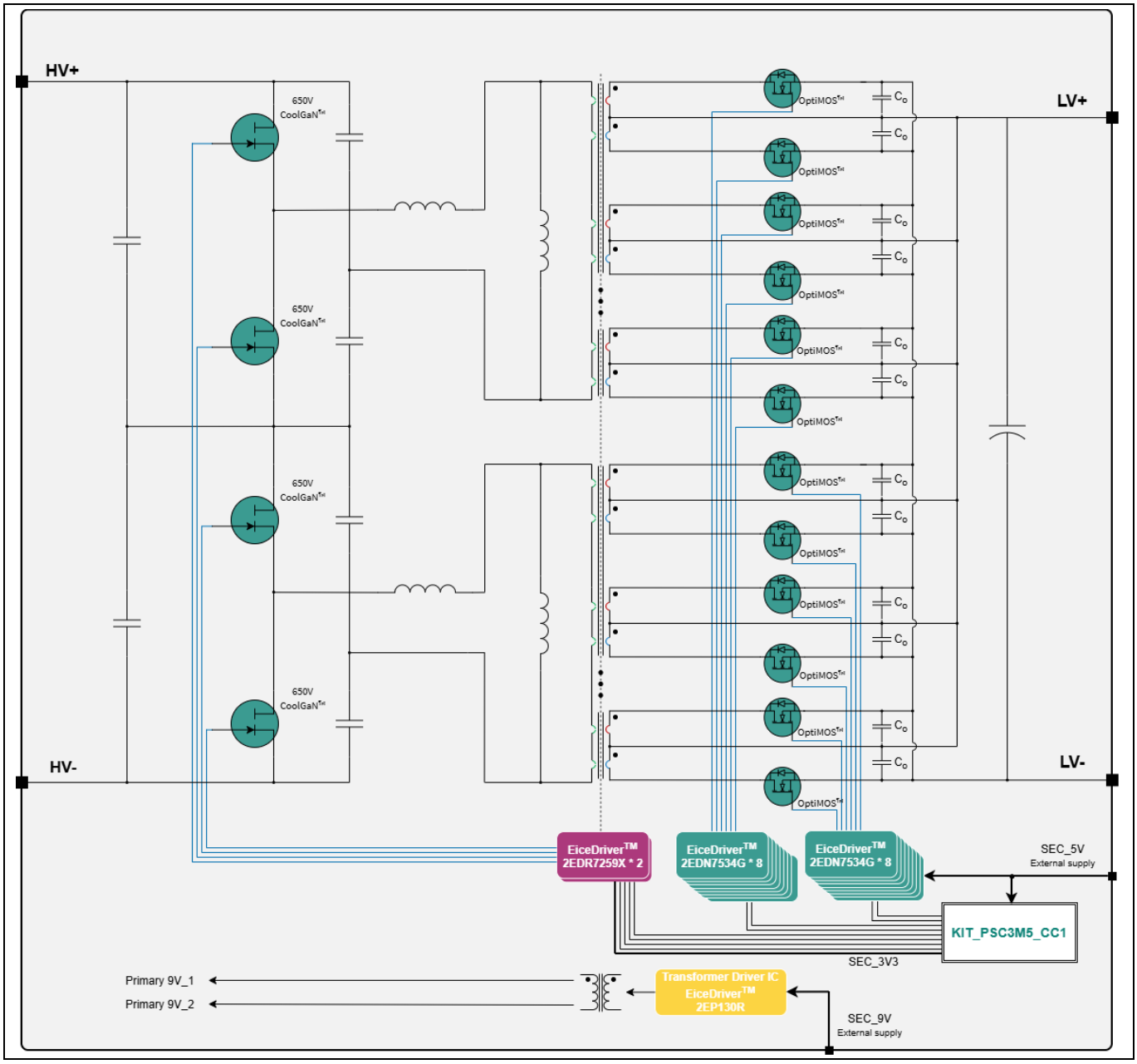



**Figure 2 Simplified schematic of REF_6KW_800V_12V_IBC module**

## 1.3 Main features

- 6-kW isolated HVIBC reference board with a nominal 800 V DC input
- Unregulated 12 V output with a maximum output current of 500 A
- CoolGaN™ Transistor 650 V G5 primary-side power stage
- OptiMOS™ 7 power MOSFET secondary-side synchronous rectification
- Stacked half-bridge LLC topology with ISOP architecture
- Up to 98.2% peak efficiency and approximately 97.1% efficiency at full load
- PCB-integrated planar transformer with a matrix-transformer-based winding structure
- Converter board dimensions of 130 mm × 40 mm × 8 mm (L × W × H)
- Top-side-cooling semiconductor package for external heatsink or liquid-cooling solutions
- Operation with the external KIT_PSC3M5_CC1 Digital Power Control Card

## 1.4 Board specifications

Table 2 lists the specifications for the Infineon REF_6KW_800V_12V_IBC.

Specifications are given for ambient temperature (Ta) = 25°C unless otherwise specified.

**Table 2 Specifications**

| Parameter | Symbol | Value | | | Unit | Conditions/notes |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| DC input voltage (+) | $V_{IN+}$ | – | – | 800 | V | Dual rail HV input |
| DC input voltage (-) | $V_{IN-}$ | 0 | – | – | V | Dual rail HV input |
| DC input current | $I_{IN}$ | – | – | 8.5 | A | $V_{IN}$ = 800 V, $P_{OUT}$ = 6 kW |
| DC output voltage | $V_{OUT}$ | 11.87 | 12.50 | 13.13 | V | – |
| Maximum output current | $I_{OUT}$ | – | – | 500 | A | – |
| Maximum output power | $P_{OUT}$ | – | – | 6000 | W | – |
| Peak efficiency | $\eta_{PEAK}$ | – | 98.0 | – | % | At $I_{OUT}$ = 175 A, $P_{OUT}$ = 2.1 kW |
| Full load efficiency | $\eta_{FULL_LOAD}$ | – | 97.0 | – | % | At $I_{OUT}$ = 500 A, $P_{OUT}$ = 6 kW |
| Switching frequency | $f_{SW}$ | – | 780 | – | kHz | Fixed frequency |
| Power density | – | – | >2000 | – | $W/in^3$ | Based on the board dimensions |
| Dimensions | 130 × 40 × 8 | | | | mm | L × W × H |
| Operating temperature | $T_{OP}$ | – | – | 70 | °C | Heatsink with liquid cooler |

# 2 Hardware setup and evaluation environment

Figure 3 shows the recommended test setup and electrical connections for evaluating the REF_6KW_800V_12V_IBC reference board. The setup comprises the reference board, the KIT_PSC3M5_CC1 Digital Power Control Card, a high-voltage DC source, a load, and the required auxiliary supplies. Figure 3 does not show the thermal management hardware. An external heatsink or liquid-cooling solution is required for high-power testing to keep the power components within their specified temperature limits.

An external 9 V supply powers the isolated bias-generation circuit for the primary-side gate drivers. An external 5.7 V supply powers the secondary-side synchronous-rectifier gate drivers. The KIT_PSC3M5_CC1 control card requires a separate external supply and generates the 3.3 V rail and control signals used by the reference board.

Perform testing on a heat-resistant, electrically insulating surface in a well-ventilated area. Follow the applicable high-voltage safety procedures and use appropriate personal protective equipment (PPE). Before making or changing connections, disconnect all power sources and verify that the high-voltage nodes have discharged. Provide any external protection required for the test setup; the reference board does not implement the system-level protection functions described in Section 1.2.

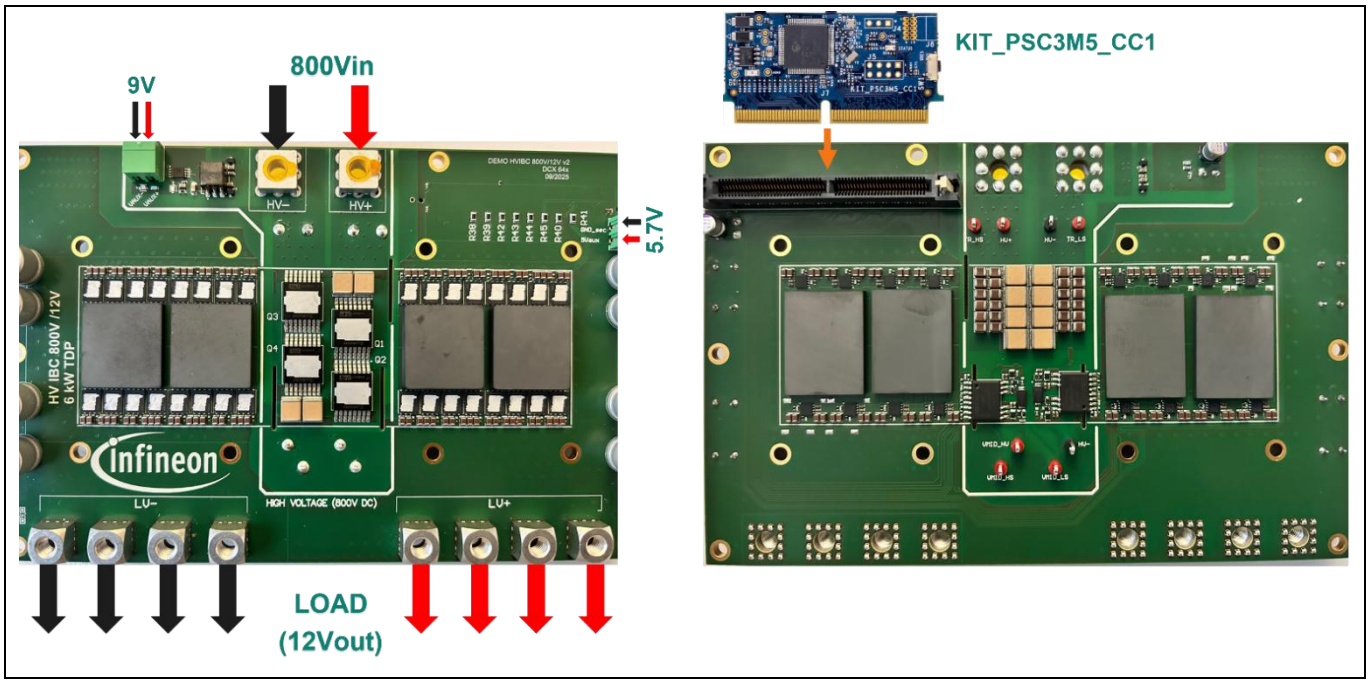



**Figure 3 Hardware setup and system interconnections**

## 2.1 HVIBC power reference board

The REF_6KW_800V_12V_IBC reference board integrates the LLC power stages, magnetic components, gate-driver circuits, and supporting passive components. Figure 4 identifies the board interfaces and mounting locations.

Figure 4 (a) shows the front side of the reference board. The HV+ and HV− terminals connect to the high-voltage DC source; the input voltage is measured between these terminals. The LV+ and LV− terminals connect to the load and provide the nominal 12 V output and its return, respectively. The front side also includes the auxiliary-supply connections and mounting holes for an external cooling assembly.

Figure 4 (b) shows the back side of the reference board. Connector X13 provides the interface to the KIT_PSC3M5_CC1 Digital Power Control Card. The control card supplies the PWM signals and 3.3 V rail required by the driver interfaces and associated control circuitry. The control card requires a separate external supply.

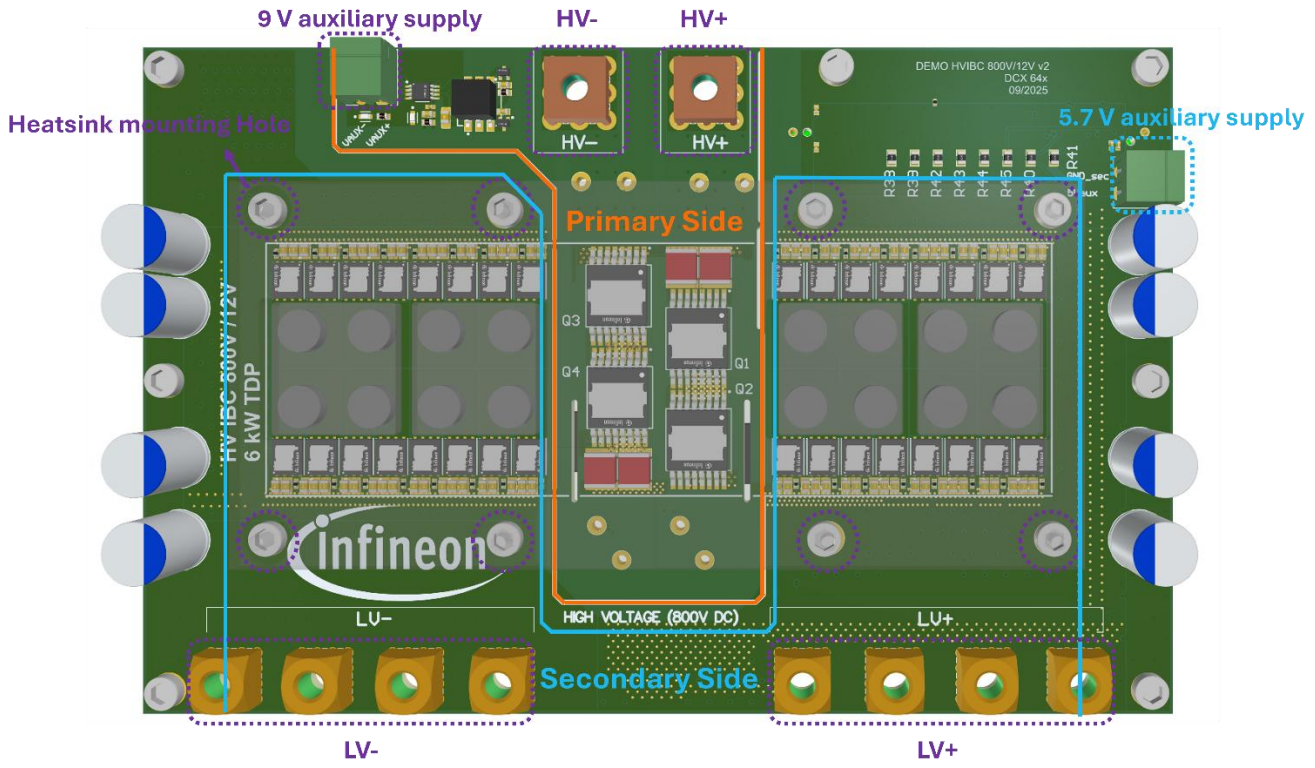
The reference board also requires two external auxiliary supplies. Connect a 9 V supply to VAUX+ and VAUX− for the primary-side gate-driver bias-generation circuit. Connect a 5.7 V supply to 5VAUX+ and GND_SEC for the secondary-side SR gate drivers.

The reference board supports an external heatsink or liquid-cooling assembly. Mounting holes are provided for the cooling assembly. Suitable thermal interface material (TIM) shall be placed between the cooling assembly and the designated contact surfaces of the top-side-cooled power devices and transformer cores. The cooling assembly and TIM are not included with the reference board.

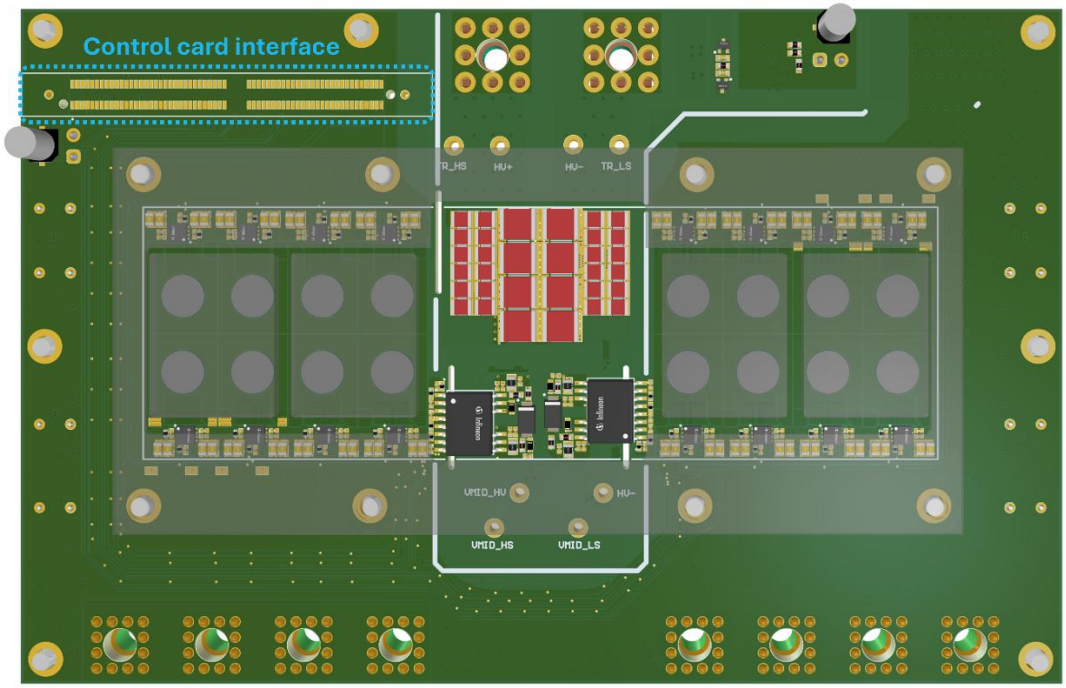
Table 3 identifies the board terminals and connector used for the high-voltage input, low-voltage output, auxiliary supplies, and control card.

**Table 3 Board terminals**

| Name | Description | Comment |
|---|---|---|
| HV+ | High-voltage positive input | Positive terminal of the DC input |
| HV− | High-voltage negative input | Negative terminal of the DC input |
| LV+ | 12 V DC output | Positive output terminal |
| LV- | 12 V DC output return | Negative output terminal |
| VAUX+ | External 9 V auxiliary supply input | Primary-side gate-driver bias |
| VAUX- | External 9 V auxiliary supply return | Primary-side gate-driver bias |
| 5VAUX | External 5.7 V auxiliary supply input | Secondary-side SR driver supply |
| GND_SEC | External 5.7 V auxiliary supply return | Secondary-side SR driver supply |
| X13 | KIT_PSC3M5_CC1 interface connector | Control card and 3.3 V supply interface |




(a) Front-side view




(b) Back side view

**Figure 4 REF_6KW_800V_12V_IBC reference board: (a) front-side view and (b) back-side view**

## 2.2 Required test equipment

- Programmable high-voltage DC power supply capable of providing up to 800 V input
- Electronic load capable of sinking up to 500 A at 12 V
- Oscilloscope and voltage/current probes for waveform measurement
- Digital multimeter for voltage and current verification
- Thermal imaging camera or infrared thermometer
- High-voltage and high-current rated cables and connectors
- Appropriate personal protective equipment (PPE)

## 2.3 Recommended power-up sequence

***Attention:*** ***The REF_6KW_800V_12V_IBC reference board does not implement soft start or the protection and fault-management functions described in Section 1.2. Do not apply the full 800 V input directly at startup. Use the controlled voltage-ramp procedure below and provide the external protection required for the test setup.***

Before power-up, install an external heatsink or liquid-cooling plate with suitable thermal interface material (TIM) contacting the designated surfaces of the power semiconductors and transformer cores. Verify that the cooling system operates correctly. Do not use the absence of a heatsink or liquid-cooling plate as a basis for a specified output-power limit; operation without the specified cooling assembly is outside the recommended setup in this section.

Connect the electronic load to LV+ and LV−, but keep it disabled during the input-voltage ramp. Confirm that the high-voltage DC supply is disabled and set to 0 V. Verify the polarity and connections of the high-voltage input, the 9 V and 5.7 V auxiliary supplies, and the separate supply for the KIT_PSC3M5_CC1 Digital Power Control Card.

1. Enable the 9 V and 5.7 V auxiliary supplies
2. Power the KIT_PSC3M5_CC1 control card. Verify that the required supply rails are present and that the PWM signals for the primary- and secondary-side gate drivers are operating as intended
3. Set the high-voltage DC power supply current limit to 2 A or less
4. Enable the high-voltage DC supply. Increase the input voltage, measured between HV+ and HV−, from 0 V to 80 V in **1 V increments**. Keep the electronic load disabled, and monitor the input current and output voltage. At an 80 V input, the measured no-load output voltage is approximately **1.25 V**. Treat this value as a reference measurement, not an acceptance limit. Stop the test if the input current, output voltage, or switching behavior is abnormal
5. After confirming operation at 80 V, increase the input voltage from 80 V to 800 V in **100 V increments**. At each step, monitor the input current and output voltage. Keep the electronic load disabled throughout the voltage ramp
6. At an 800 V input, verify the nominal 12.5 V output and confirm normal operation. Only then enable the electronic load and increase its current setpoint gradually. Adjust the high-voltage supply current limit as required for the intended load, without exceeding the ratings of the supply, cables, connectors, or reference board

If abnormal input current, output voltage, temperature, or switching behavior occurs, disable the high-voltage input immediately. Before inspecting or changing connections, isolate all power sources and verify that the high-voltage nodes have discharged in accordance with the applicable safety procedure.

## 2.4 Reference cooling solution

The REF_6KW_800V_12V_IBC reference board requires an external cooling solution for normal operation. Figures 5–7 show the reference configuration used for laboratory evaluation. The cooling hardware is not included with the reference board and must be sourced separately or replaced with a suitable alternative.

An alternative cooling solution may be used if it provides appropriate thermal contact and maintains the power semiconductors and transformer cores within their specified temperature limits under the intended operating conditions. Verify the performance of an alternative solution by measurement. For information on the reference hardware and mounting configuration, contact the Infineon IBC SAE team.

Figure 5 shows the reference cooling assembly mounted on the board. The assembly consists of a heatsink and a liquid-cooling plate mounted above it. The figure identifies the principal mounting dimensions, Denka FSL100BS TIM, and Alphacool ES Stream LGA4677/SP5 LGA6096 1U liquid-cooling plate.

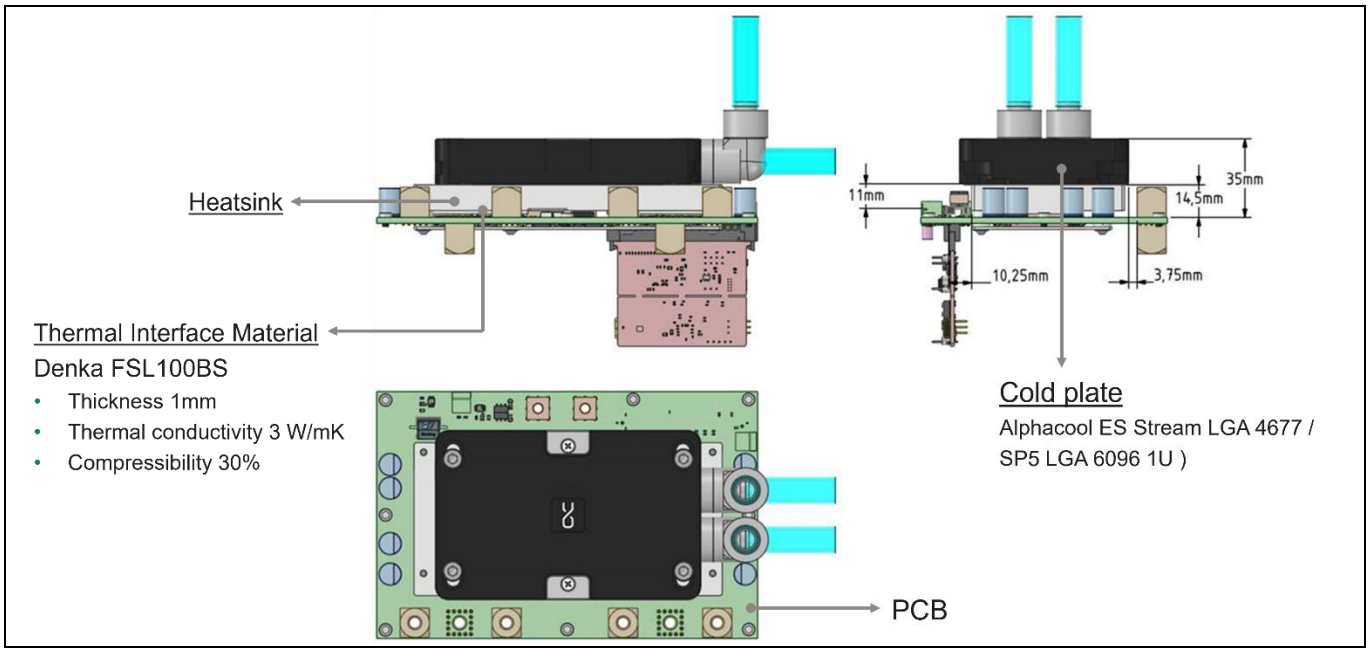



**Figure 5 Reference heatsink and liquid-cooling plate mounted on the REF_6KW_800V_12V_IBC reference board**

Figure 6 shows the heatsink mounting surfaces and hardware. The cold plate attaches to the top of the heatsink, and the bottom of the heatsink faces the reference board. TIM is placed on designated areas of the heatsink bottom so that, when assembled, it contacts the power semiconductors and transformer cores.

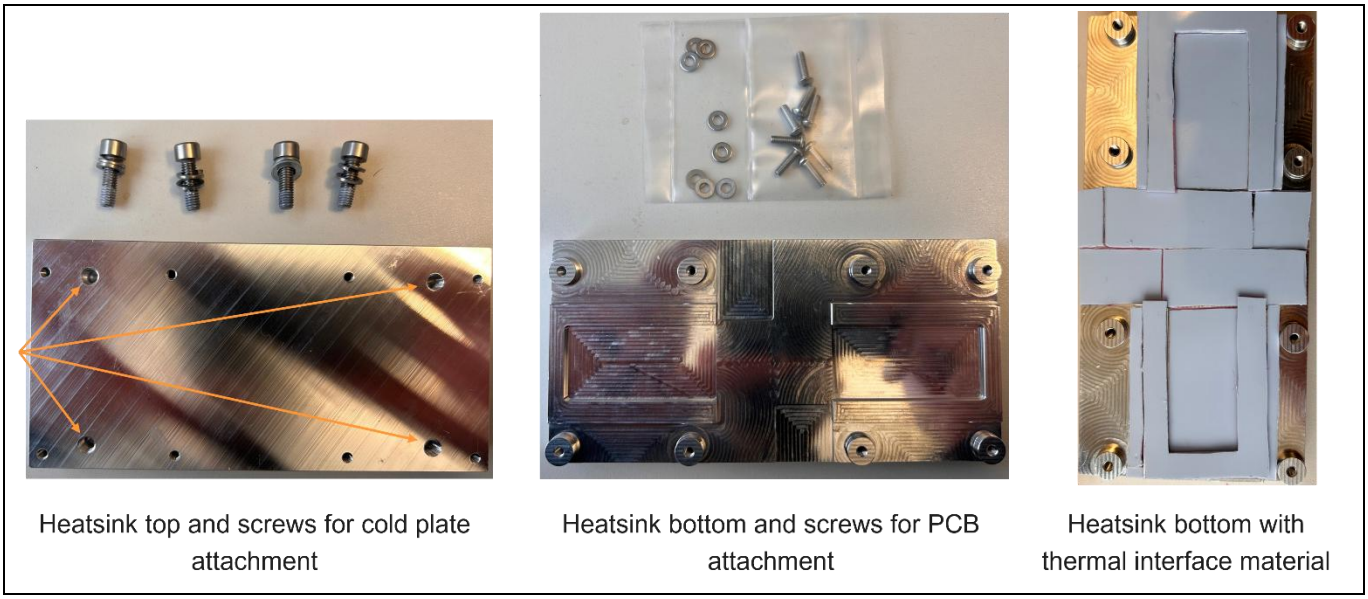



**Figure 6 Reference heatsink mounting surfaces, hardware, and TIM placement**

Figure 7 shows the assembled liquid-cooling system and laboratory setup. A thin layer of thermal grease is applied between the mating surfaces of the heatsink and liquid-cooling plate. This interface is separate from the TIM shown in Figure 6. The liquid-cooling plate is connected to the chiller through hoses and compression fittings. Before applying power, verify that the assembly is secure and that coolant is circulating.

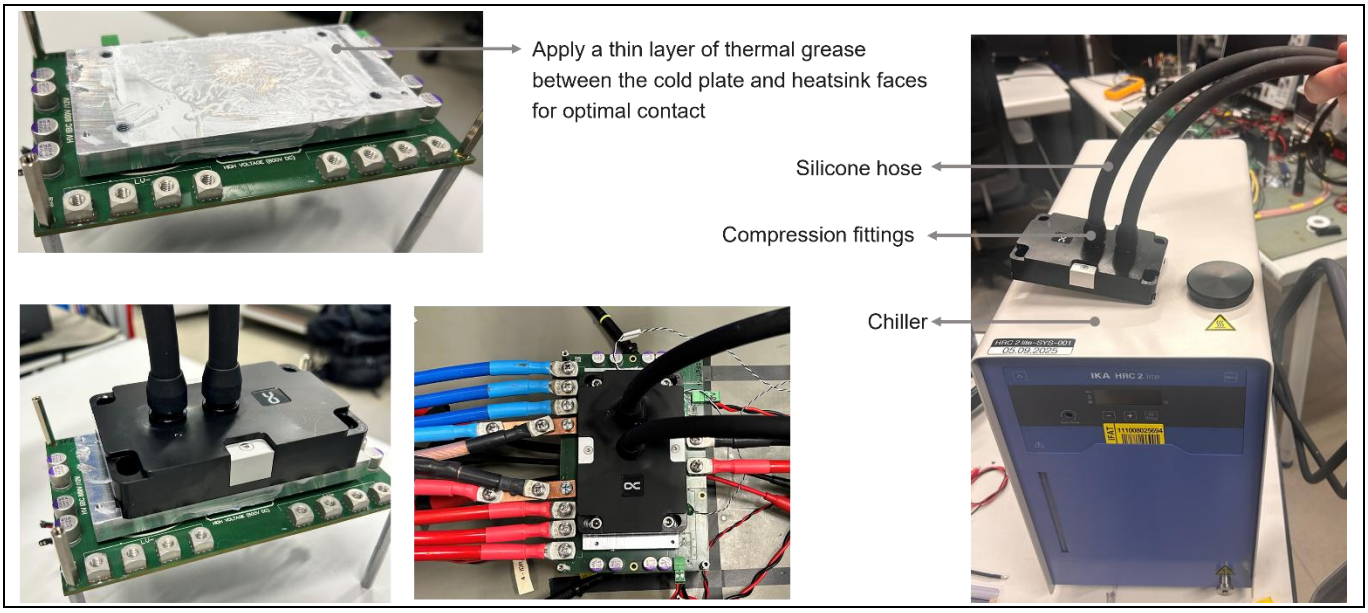



**Figure 7 Reference liquid-cooling assembly and laboratory setup**

*Note: The liquid-cooling plate shown in Figure 5, Figure 6, and Figure 7must be sourced separately or replaced with a suitable alternative.*

# 3 Functional description

## 3.1 Power stage

Figure 8 shows the simplified power-stage architecture of the REF_6KW_800V_12V_IBC. The converter comprises two half-bridge LLC stages, referred to as the upper and lower stages, in an ISOP configuration. Their primary-side inputs are connected in series across HV+ and HV−, while their secondary-side outputs are connected in parallel to provide a nominal, unregulated 12 V output. The nominal voltage between HV+ and HV− is 800 V DC. The series-connected input capacitors establish an internal midpoint; under nominal conditions, each LLC stage operates across approximately 400 V. No external midpoint connection is required.

Each LLC stage comprises a primary-side half-bridge and eight parallel CTSR branches on the secondary side. In the equivalent circuit shown in Figure 8, $C_{res}$ denotes the equivalent resonant capacitance implemented using multiple physical capacitors. The $C_{res}/2$ labels represent equivalent-circuit values and do not indicate the number of installed capacitors. $L_r$ represents the resonant inductance provided by transformer leakage inductance; no separate resonant inductor is used. $L_m$ represents the transformer magnetizing inductance.

The LLC transformers provide galvanic isolation between the primary- and secondary-side power circuits. The upper and lower LLC stages operate with a 90° phase shift to interleave their output currents and reduce output-current ripple.

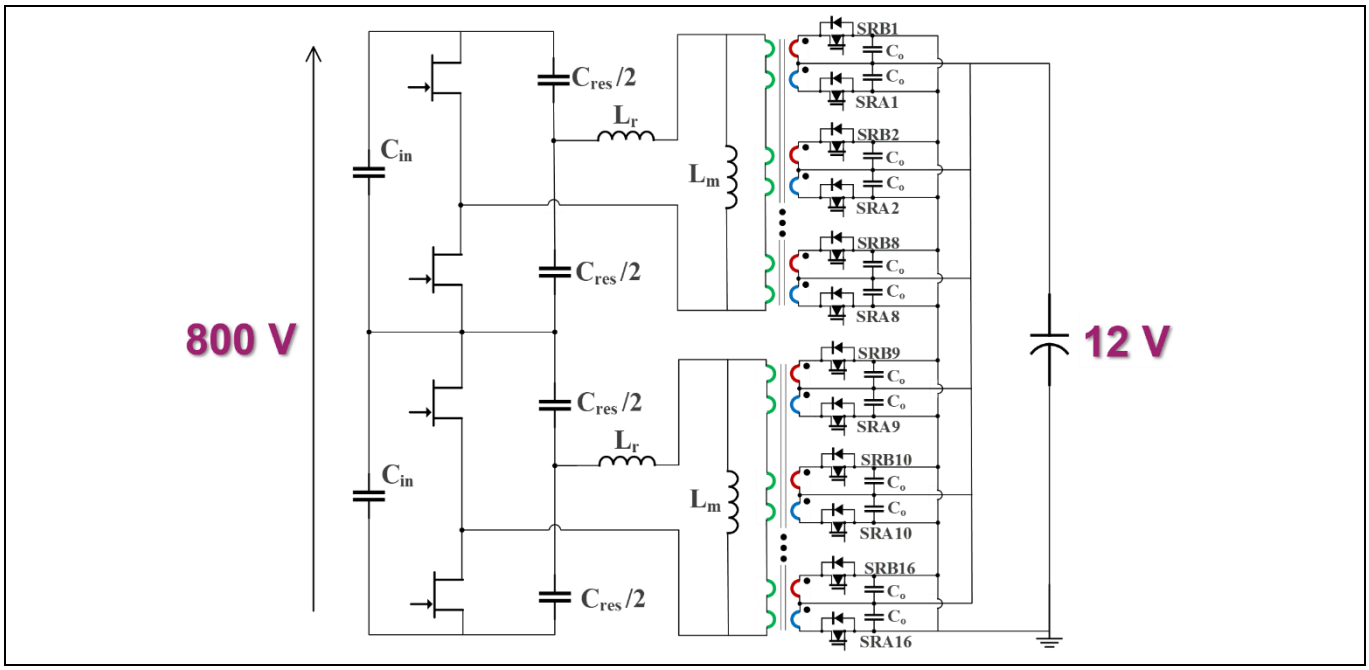



**Figure 8 Simplified power-stage architecture of the REF_6KW_800V_12V_IBC**

*Note: $C_{res}/2$ and $L_r$ are equivalent-circuit representations. The resonant capacitance is implemented using multiple capacitors, and the resonant inductance is provided by transformer leakage inductance.*

## 3.2 Primary-side gate driver

The gate-control signals originate in the secondary-side control circuitry. A reinforced-isolated, dual-channel EiceDRIVER™ 2EDR7259X gate driver transfers the signals across the isolation barrier and drives the high-side and low-side CoolGaN™ switches in each primary-side half-bridge.

The primary-side gate-drive network uses $R_{ss}$=330 Ω, $R_{tr,on}$=4.7 Ω, and $R_{tr,off}$=0 Ω. Separate turn-on and turn-off paths allow their gate-drive impedances to be set independently. For a detailed discussion of gate-drive configurations for GaN power transistors, see *Gate drive configurations for GaN power transistors* [6].

Figure 9 shows the isolated gate-drive circuit for the upper LLC stage, including the gate driver, gate-drive components, and bias-supply connections. The lower LLC stage uses the same circuit and is omitted from the figure for clarity.

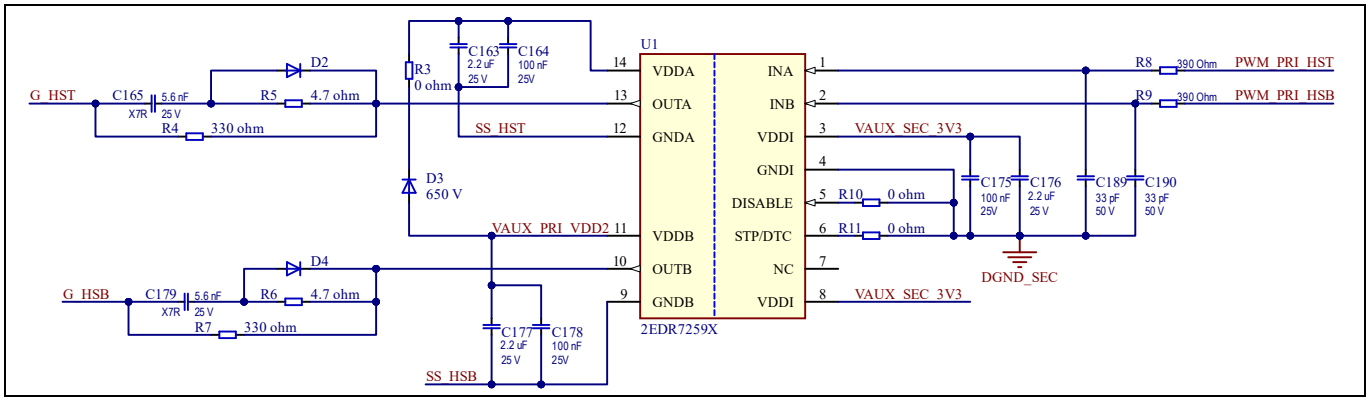



**Figure 9 Primary-side isolated gate driver circuitry**

## 3.3 Secondary-side gate driver

The secondary-side synchronous rectifiers use EiceDRIVER™ 2EDN7534G dual-channel low-side gate drivers powered by the external 5.7 V auxiliary supply. The KIT_PSC3M5_CC1 Digital Power Control Card provides the driver input signals, and the drivers supply the gate-drive signals to the OptiMOS™ 7 SR MOSFETs.

Figure 10 shows a representative secondary-side SR gate-drive circuit. The remaining CTSR branches use the same gate-drive configuration and are omitted for clarity. The circuit shown includes the driver input connections, supply decoupling components, and gate connections to the corresponding MOSFETs.

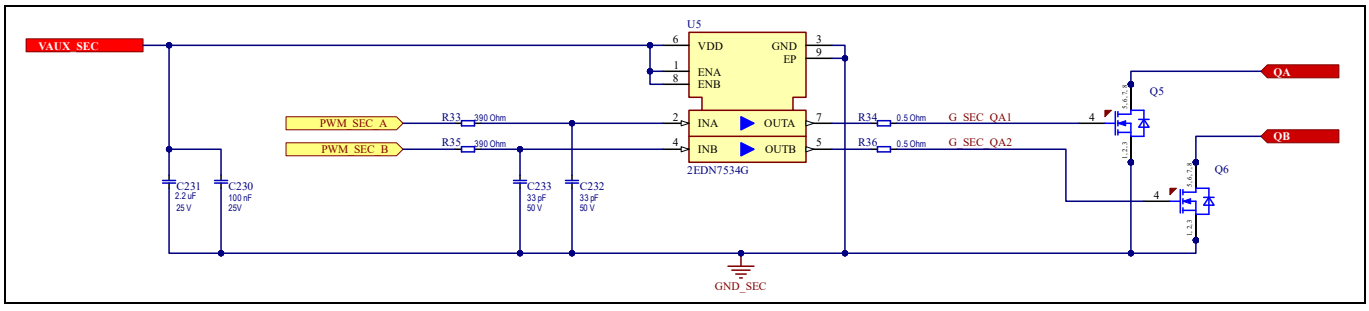



**Figure 10 Secondary-side SR gate driver circuitry**

## 3.4 Primary-side bias supply

An external 9 V auxiliary supply connected to VAUX+ and VAUX− powers the primary-side bias-generation circuit. Figure 11 shows the circuit, which uses an EiceDRIVER™ 2EP130R transformer driver and a multi-output isolation transformer to generate two isolated bias rails, VAUX_PRI_VDD1 and VAUX_PRI_VDD2.

The transformer outputs are rectified and filtered to provide bias power for the gate drivers of the upper and lower LLC stages. The two rails have separate return connections, as shown in Figure 11.

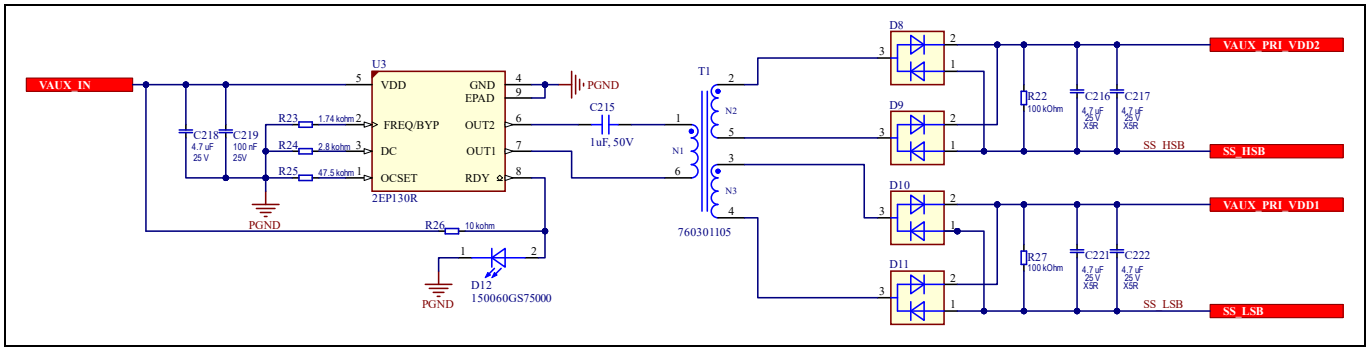



**Figure 11 Primary-side isolated bias-supply generation circuit**

## 3.5 Digital control interface

The REF_6KW_800V_12V_IBC interfaces with the KIT_PSC3M5_CC1 Digital Power Control Card through connector X13. The control card provides PWM signals for the primary-side LLC stages and secondary-side SRs, as well as a 3.3 V supply for the driver-interface circuitry. Figure 12 shows the interface connections relevant to the reference board.

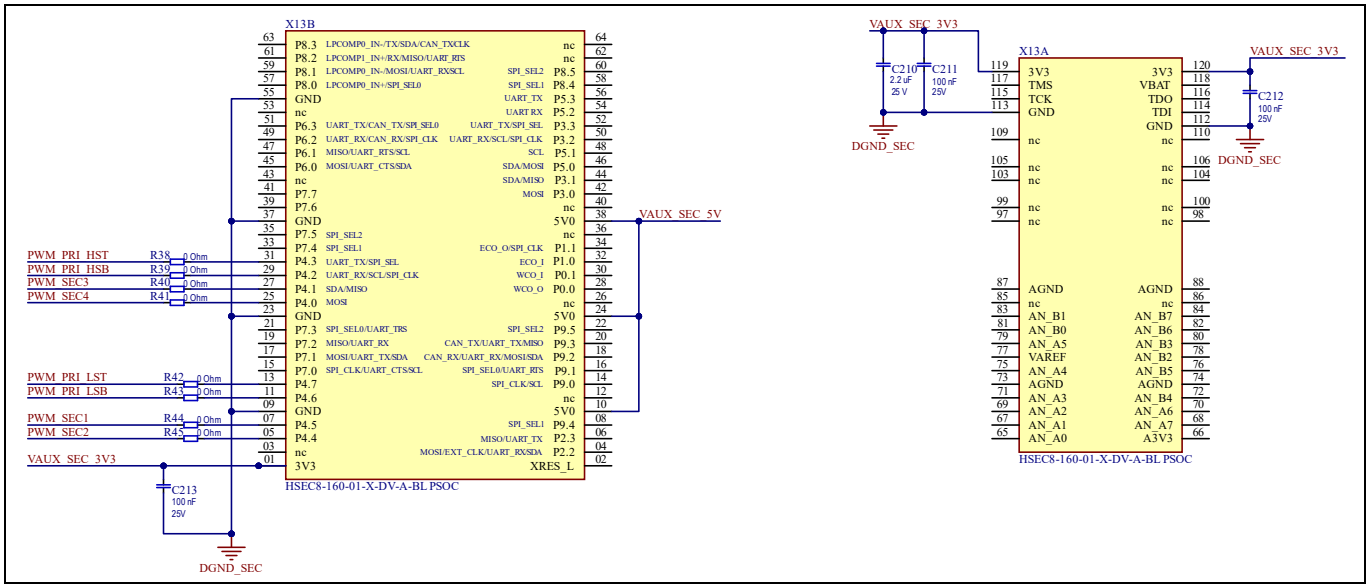



**Figure 12 Simplified control-interface connection**

## 3.6 Planar transformer design

The LLC transformers use planar windings formed in the PCB copper layers. This construction integrates the windings into the low-profile REF_6KW_800V_12V_IBC reference board.

The transformer structure comprises multiple primary- and secondary-winding sections distributed across the PCB layers. The converter voltage conversion depends on both the winding configuration and the input-series, output-parallel (ISOP) architecture; it is not determined by the transformer turns ratio alone.

### 3.6.1 Winding arrangement

The transformer windings and shielding layers are implemented in a 12-layer PCB. The primary winding occupies L5–L8, and the secondary winding occupies L1–L3 and L10–L12. Layers L4 and L9 serve as shields

between the primary and secondary winding regions; they are intended to reduce capacitive coupling and common-mode noise.

Table 4 lists the layer assignments. Each of the four primary layers is designated as a half-turn winding section. The secondary layers contain winding sections for secondary groups A and B, as identified in the table.

**Table 4 Planar transformer winding arrangement**

| 12 layers | Layer |
|---|---|
| Sec A. turn | L1 |
| Sec B. turn | L2 |
| Sec A. turn | L3 |
| Shielding | L4 |
| Prim. ½ turn | L5 |
| Prim. ½ turn | L6 |
| Prim. ½ turn | L7 |
| Prim. ½ turn | L8 |
| Shielding | L9 |
| Sec B. turn | L10 |
| Sec A. turn | L11 |
| Sec B. turn | L12 |

### 3.6.2 PCB stackup

Table 5 shows the PCB stackup used for the planar transformers. The 12-layer board uses 2 oz copper on the secondary-winding and shielding layers and 3 oz copper on the primary-winding layers. The winding arrangement is described in Section 3.6.3 and Section 3.6.4.

The stackup includes 0.25 mm core dielectric between L3 and L4 and between L9 and L10. These dimensions describe the implemented PCB construction; they do not establish a safety isolation rating. Any alternative PCB stackup or insulation system must be evaluated against the applicable electrical and safety requirements of the intended application.

**Table 5 PCB stackup of the planar transformer**

| # | Name | Material | Type | Weight | Thickness | Dk |
|---|---|---|---|---|---|---|
| | Top overlay | | Overlay | | | |
| | Top solder | Solder resist | Solder mask | | 0.02 mm | 3.5 |
| 1 | L1_Top | | Signal | 2 oz. | 0.07 mm | |
| | Dielectric1 | FR-4 | Dielectric | | 0.1 mm | 3.86 |
| 2 | L2 | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric8 | FR-4 | Core | | 0.131 mm | 3.86 |
| 3 | L3 | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric2 | FR-4 | Core | | 0.25 mm | 4.23 |
| 4 | L4_SHIELD | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric 1 | FR-4 | Prepreg | | 0.131 mm | 4.05 |
| 5 | L5 | CF-004 | Signal | 3 oz. | 0.105 mm | |
| | Dielectric 3 | FR-4 | Prepreg | | 0.1 mm | 4.23 |
| 6 | L6 | CF-004 | Signal | 3 oz. | 0.105 mm | |
| | Dielectric4 | FR-4 | Prepreg | | 0.21 mm | 4.05 |
| 7 | L7 | CF-004 | Signal | 3 oz. | 0.105 mm | |
| | Dielectric 4 | FR-4 | Prepreg | | 0.1 mm | 4.23 |
| 8 | L8 | CF-004 | Signal | 3 oz. | 0.105 mm | |
| | Dielectric 2 | FR-4 | Prepreg | | 0.131 mm | 4.05 |
| 9 | L9_SHIELD | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric6 | FR-4 | Core | | 0.25 mm | 4.23 |
| 10 | L10 | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric9 | FR-4 | Core | | 0.131 mm | 3.86 |
| 11 | L11 | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Dielectric10 | FR-4 | Prepreg | | 0.1 mm | 3.86 |
| 12 | L12_Bot | CF-004 | Signal | 2 oz. | 0.07 mm | |
| | Bottom solder | Solder resist | Solder mask | – | 0.02 mm | 3.5 |
| | Bottom overlay | | Overlay | – | – | – |

### 3.6.3 Primary winding implementation

Figure 13 shows examples of the primary-winding patterns on L5 and L6. The primary winding is distributed across L5–L8 as interconnected half-turn sections, as summarized in Table 4. This multilayer construction implements the required winding configuration within the board height.

The design uses a matrix-transformer-based winding arrangement in which winding sections are distributed across the PCB layers and interconnected in the power stage. Figure 13 shows layer patterns; the complete winding connections should be determined from the transformer and power-stage schematics rather than inferred from these images alone.

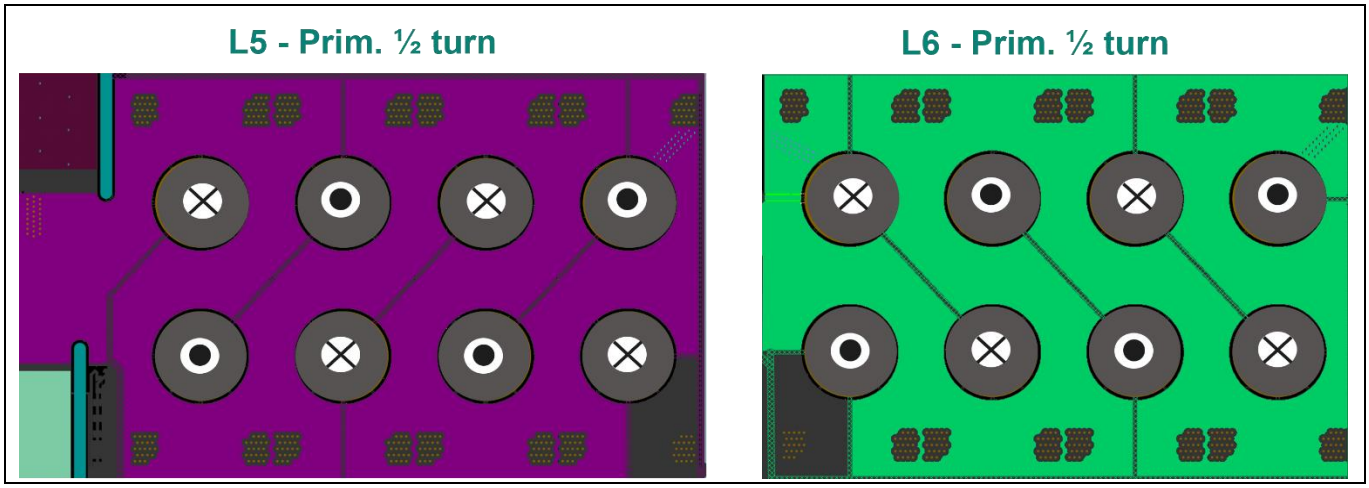



**Figure 13 PCB implementation of the primary winding**

### 3.6.4 Secondary winding implementation

Figure 14 shows the secondary-winding patterns on L1–L3 and L10–L12. The winding sections are distributed across these six layers to provide multiple current paths for the high-current output stage.

The use of multiple copper layers increases the available conductor cross-sectional area. The interconnections between the secondary winding sections and the CTSR branches determine how current is distributed among those paths.

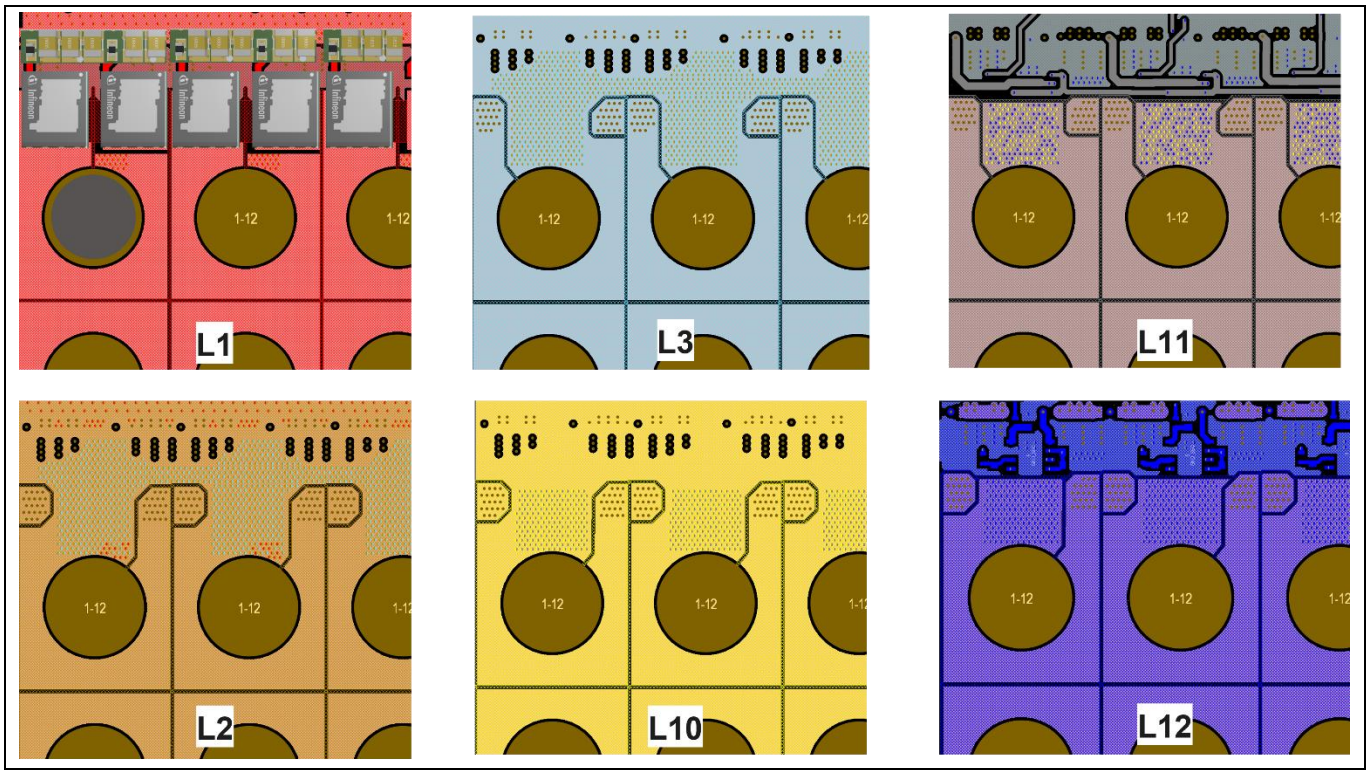



**Figure 14 PCB implementation of the secondary winding**

# 4 System performance

This chapter presents representative measurements obtained from the REF_6KW_800V_12V_IBC reference board. The results include steady-state switching waveforms, output voltage versus load current, thermal imaging, and efficiency. Unless otherwise stated, the results apply to the test conditions described with each measurement.

## 4.1 Test results

### 4.1.1 Steady-state operation

Figure 15 shows the measured drain-to-source voltage $V_{DS}$ waveforms of selected primary-side CoolGaN™ switches and secondary-side synchronous rectifiers at an 800 V input and full load. The lower traces correspond to the primary-side switches, and the upper traces correspond to the synchronous rectifiers.

The waveforms show the switching transitions of the primary-side devices and the associated secondary-side rectification during the measurement. These traces illustrate operation at the stated test point; they do not characterize switching behavior over the full operating range.

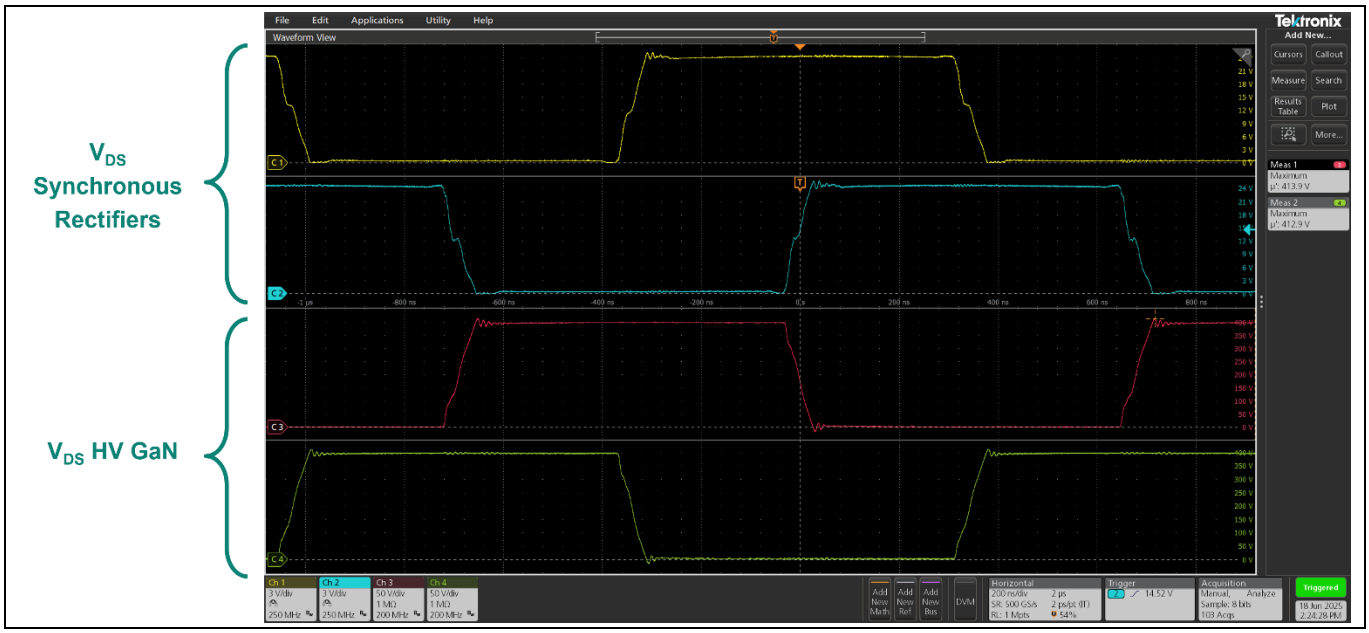



**Figure 15 Measured VDS waveforms at 800 V input and full-load operation**

### 4.1.2 Output-voltage characteristics

Figure 16 shows the measured output voltage as a function of output current at the nominal 800 V input. The converter operated open-loop, without closed-loop output-voltage regulation.

As the output current increased from 0 A to 500 A, the measured output voltage decreased from approximately 12.57 V to 12.23 V, a change of 0.34 V, or approximately 2.7% relative to the no-load value. These results describe load-dependent output-voltage variation under the stated test conditions.

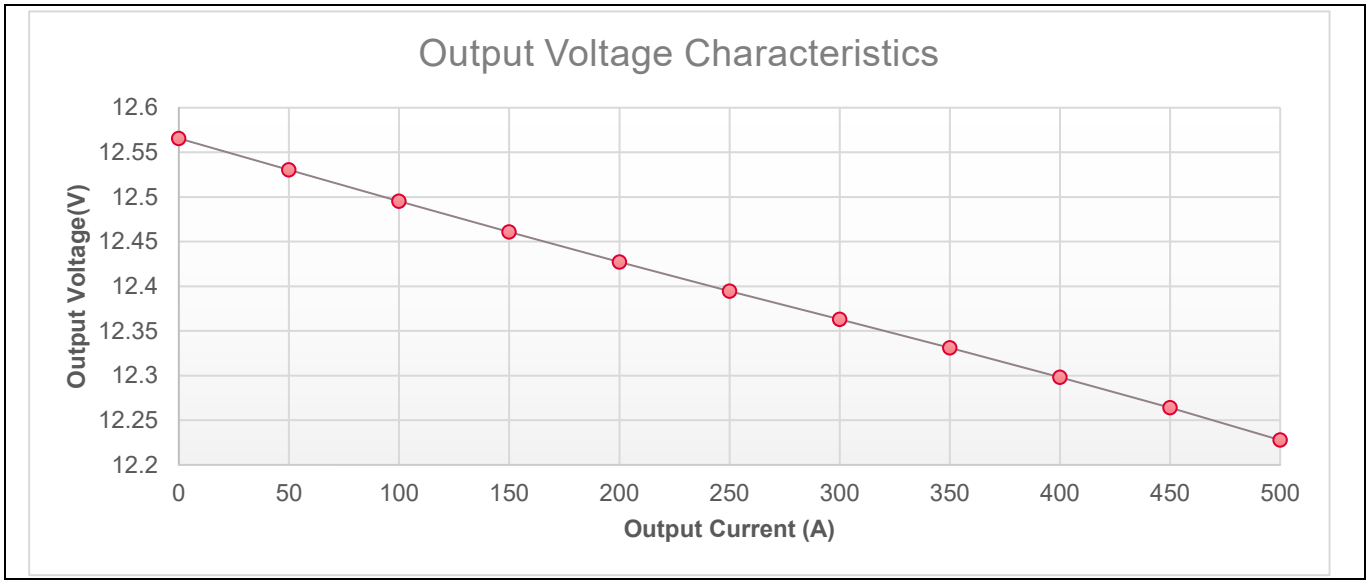



**Figure 16 Measured output voltage versus output current**

### 4.1.3 Thermal performance

Figure 17 shows a thermal image captured during an approximately 3 kW test without the external heatsink or liquid-cooling plate described in Section 2.4. Forced-air cooling was used for this measurement. The highest visible surface temperature in the image was approximately 80°C.

This image provides a representative observation of accessible surface temperatures under this specific test setup. The airflow, ambient temperature, and test duration are not specified; therefore, the measurement does not establish a general operating limit for use without an external cooling assembly. Full-power operation requires the cooling arrangement described in Section 2.4 or a thermally validated alternative.

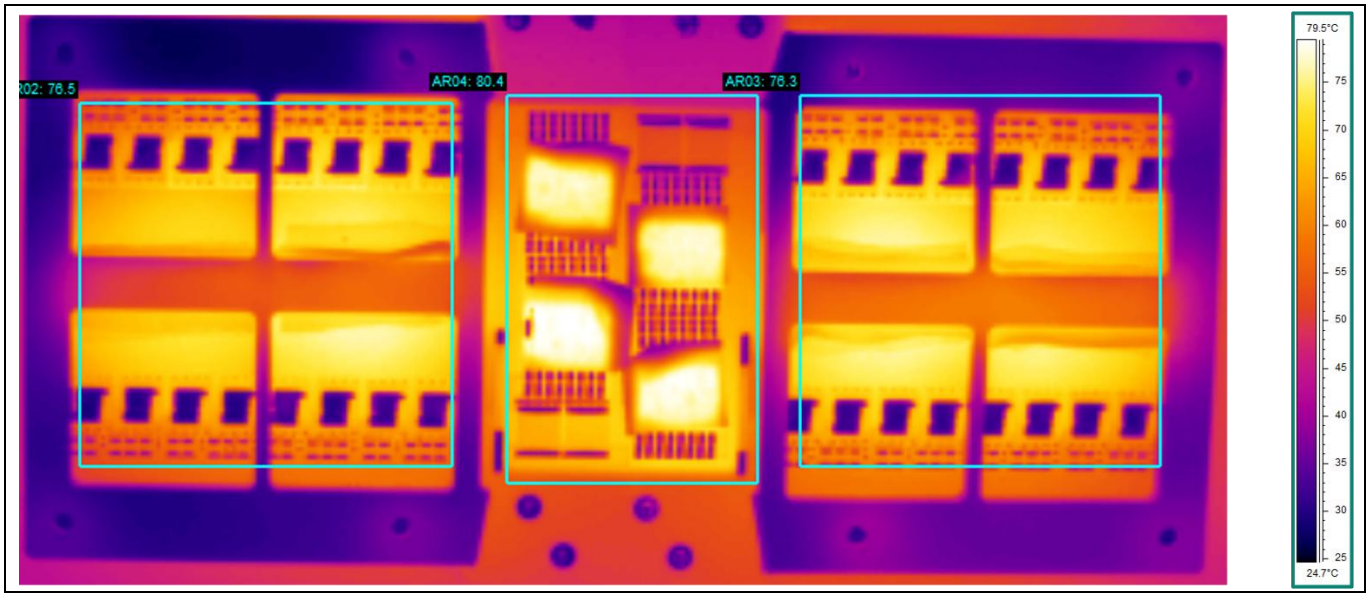



**Figure 17 Thermal image of the REF_6KW_800V_12V_IBC during approximately 3 kW operation without an external heatsink**

### 4.1.4 Efficiency measurement

Figure 18 shows efficiency versus output power for two measurement boundaries. Power-stage efficiency excludes the external auxiliary-supply power consumption. Efficiency including auxiliary power includes the auxiliary supplies used by the gate-drive and control circuits.

The peak measured power-stage efficiency was 98.21% at approximately 2 kW output power; efficiency including auxiliary power at the same test point was 97.96%.

At 6-kW output power, the measured values were 97.08% and 96.97%, respectively. The difference between the curves is attributable to the auxiliary power included in the second measurement boundary.

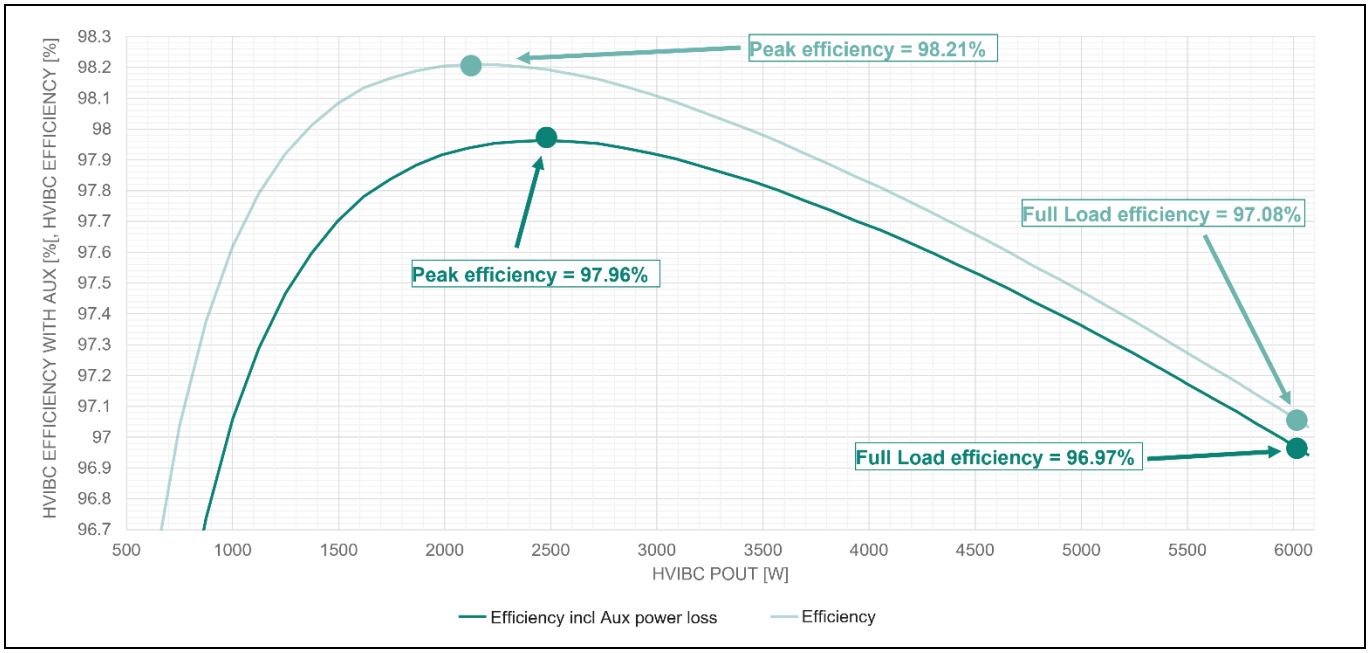



**Figure 18 Measured efficiency vs. output power**

# 5 Schematics

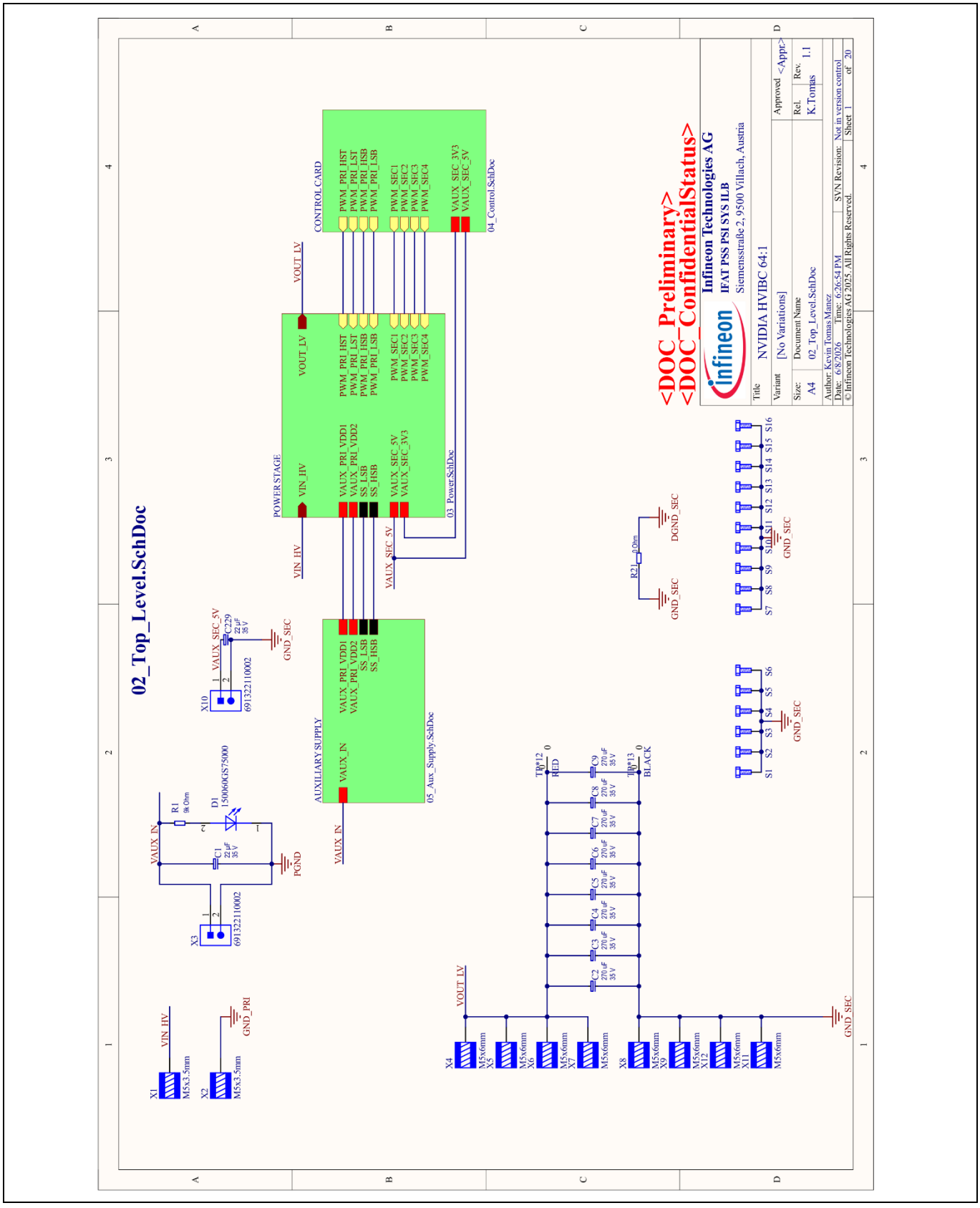



**Figure 19 Top level**

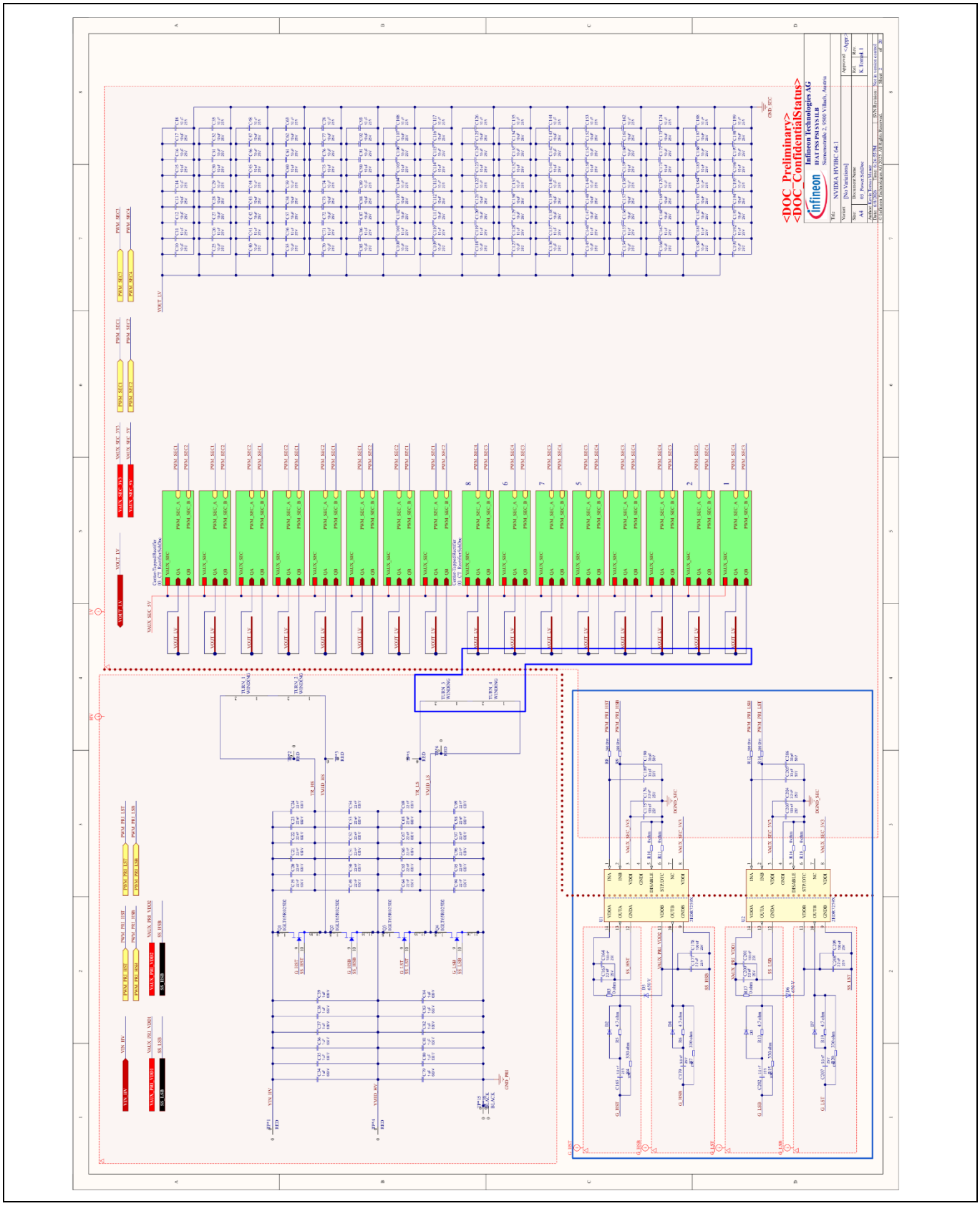


**Figure 20 Power stage**

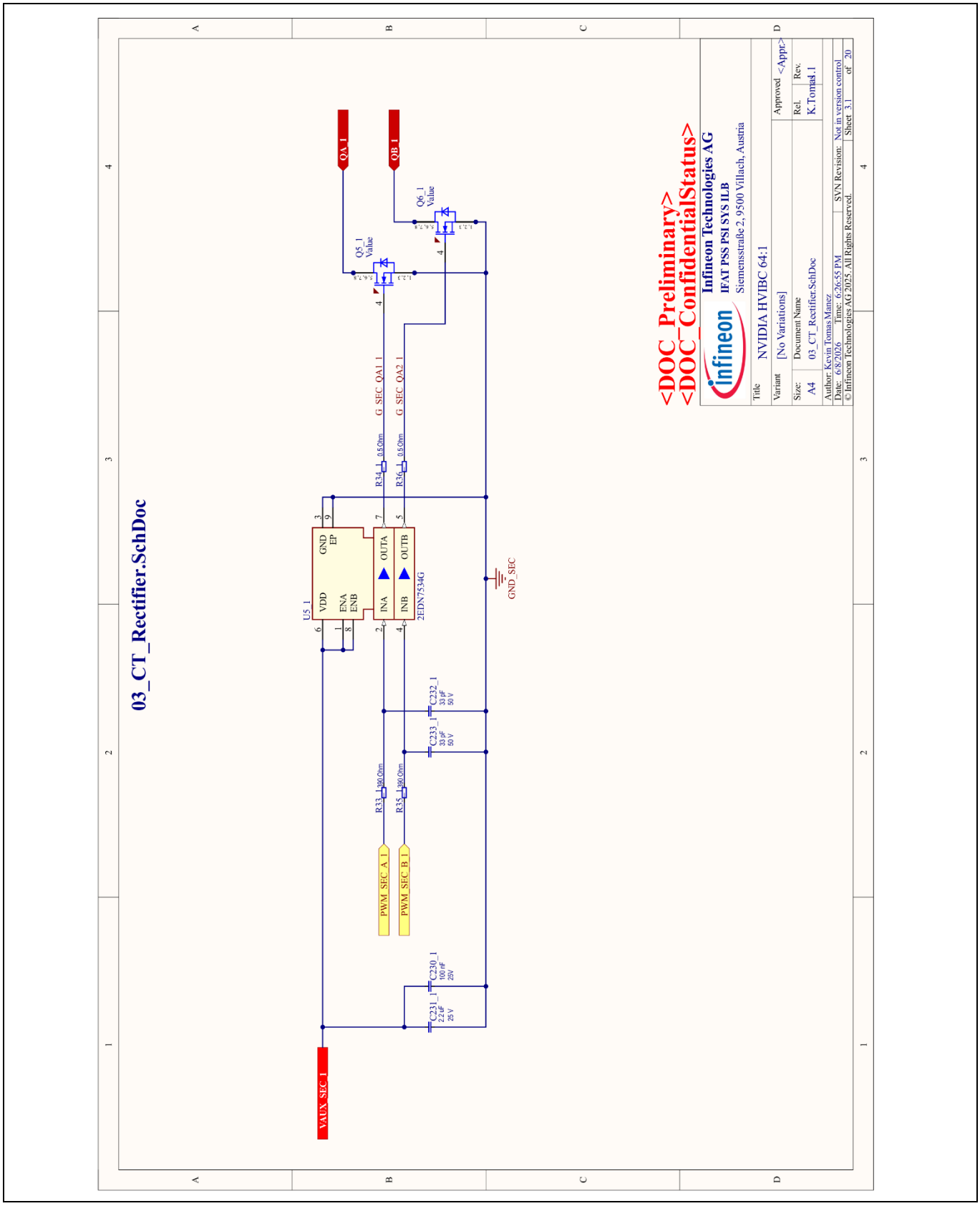



**Figure 21 CT rectifier 1**

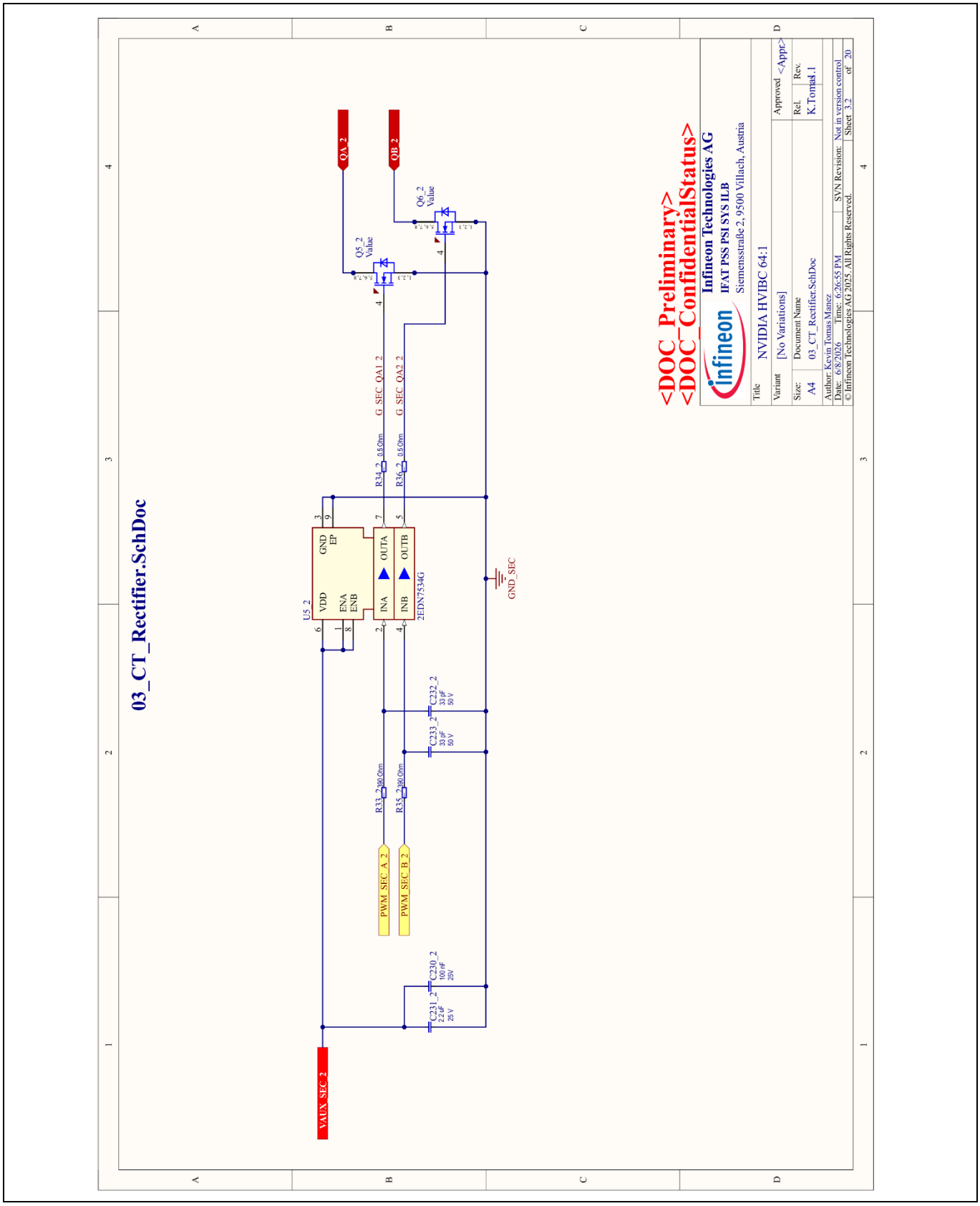



**Figure 22 CT rectifier 2**

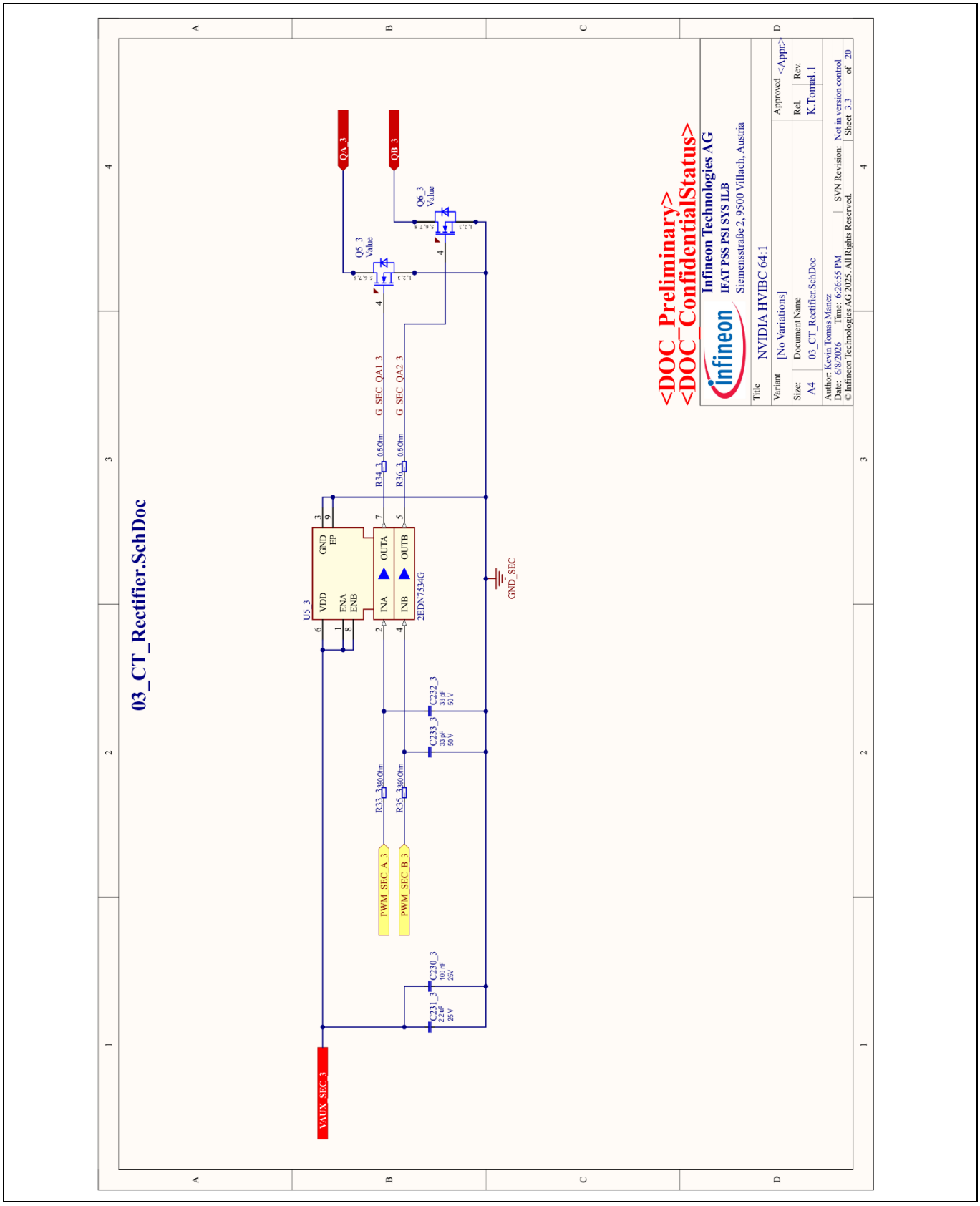



**Figure 23 CT rectifier 3**

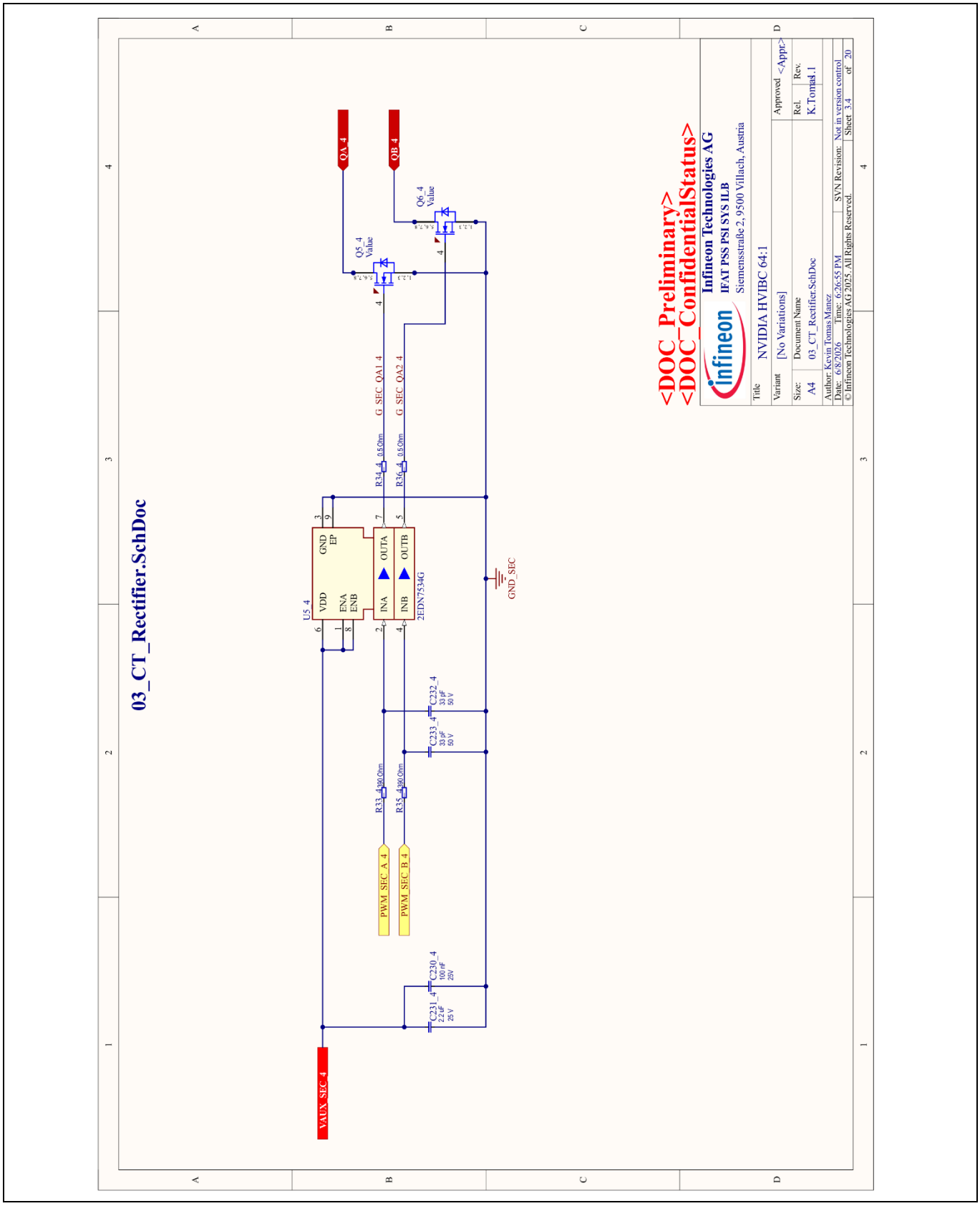



**Figure 24 CT rectifier 4**

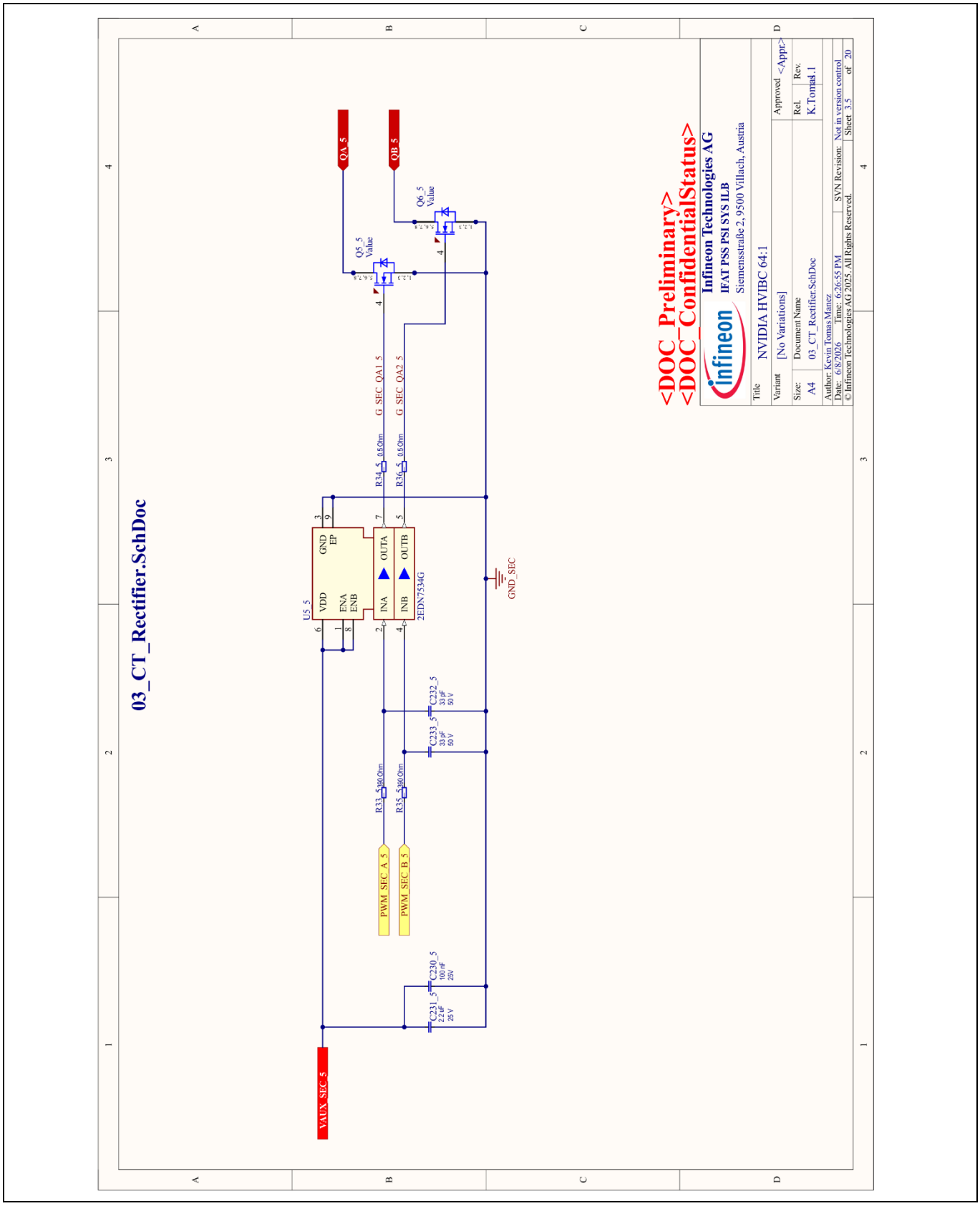



**Figure 25 CT rectifier 5**

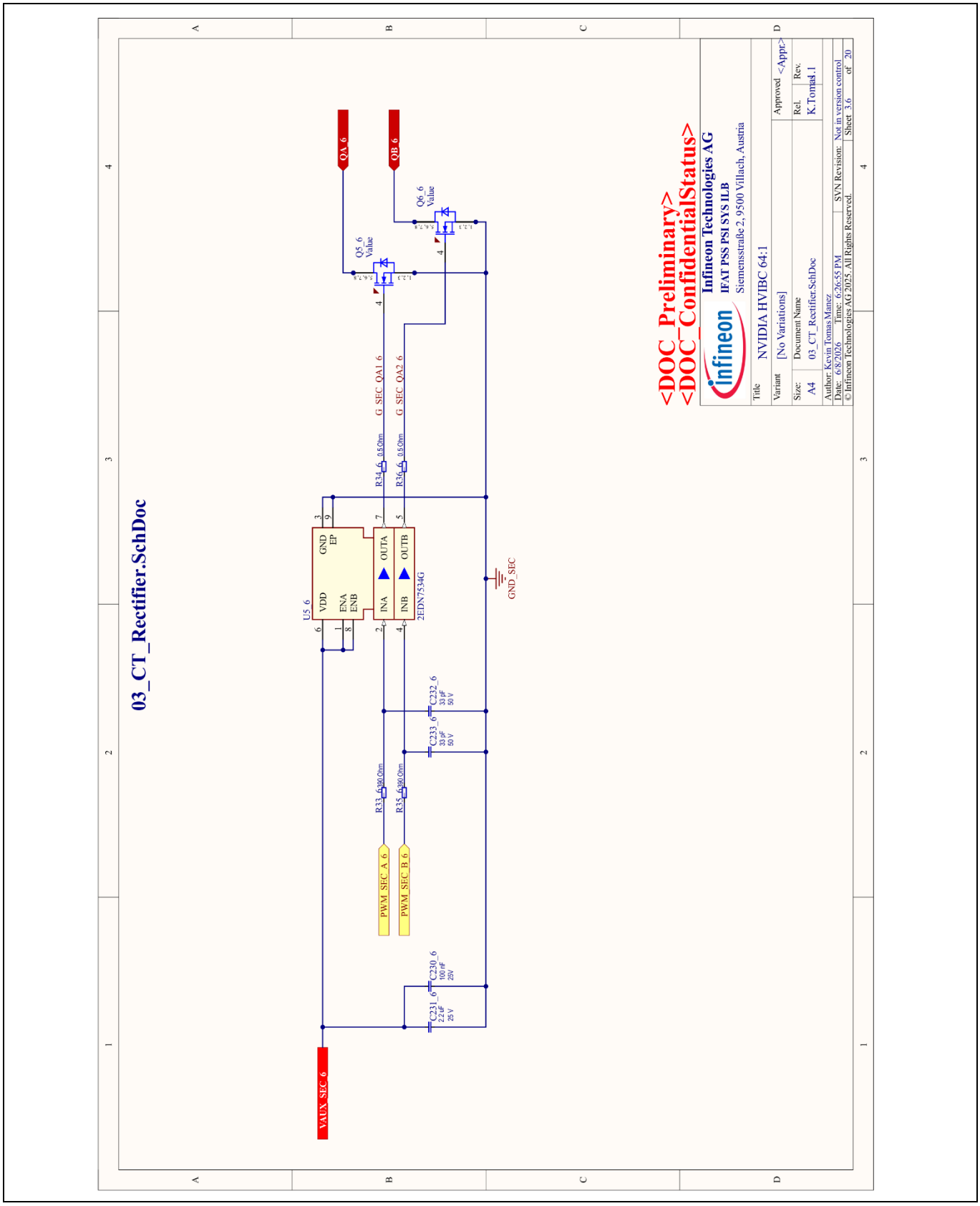



**Figure 26 CT rectifier 6**

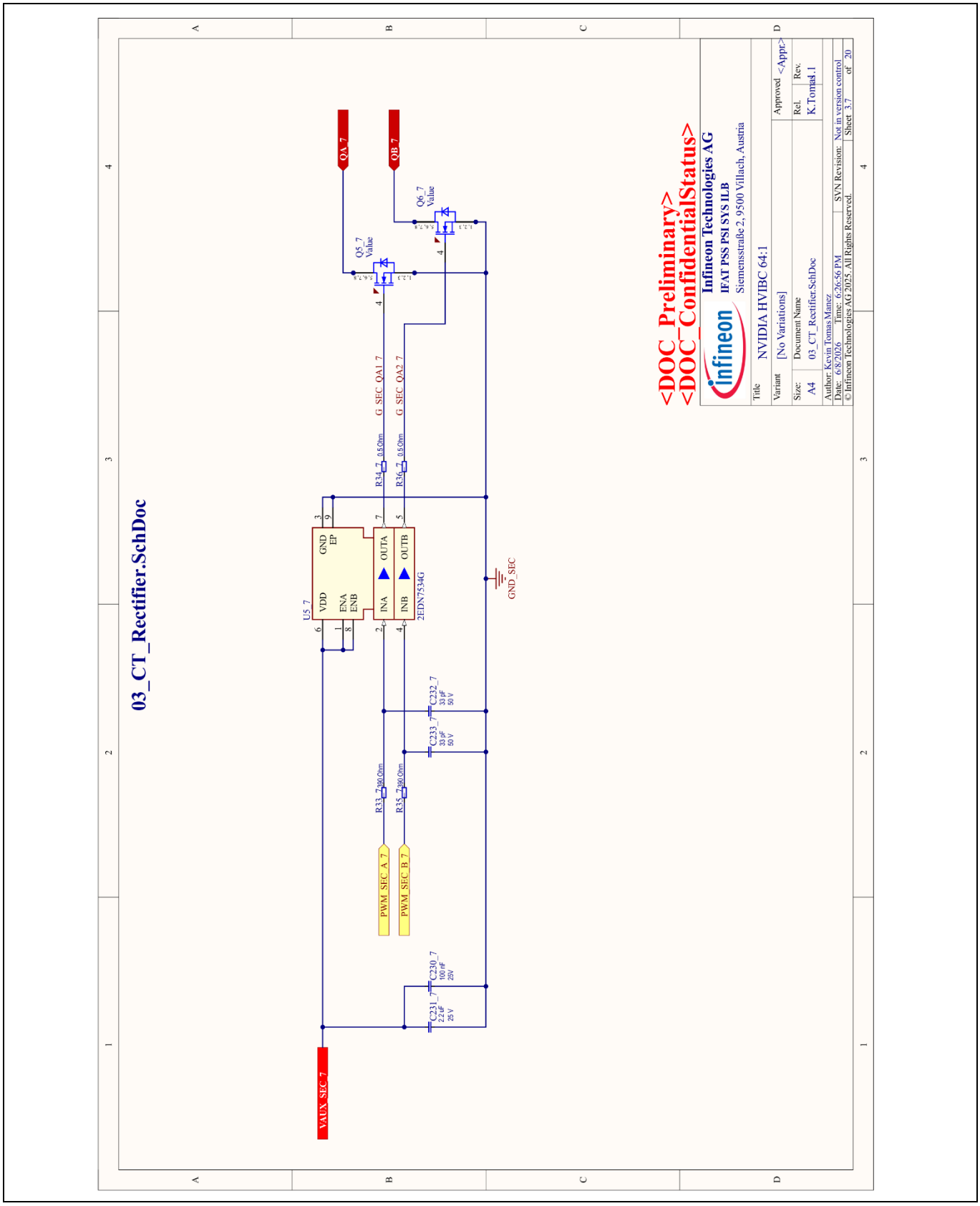



**Figure 27 CT rectifier 7**

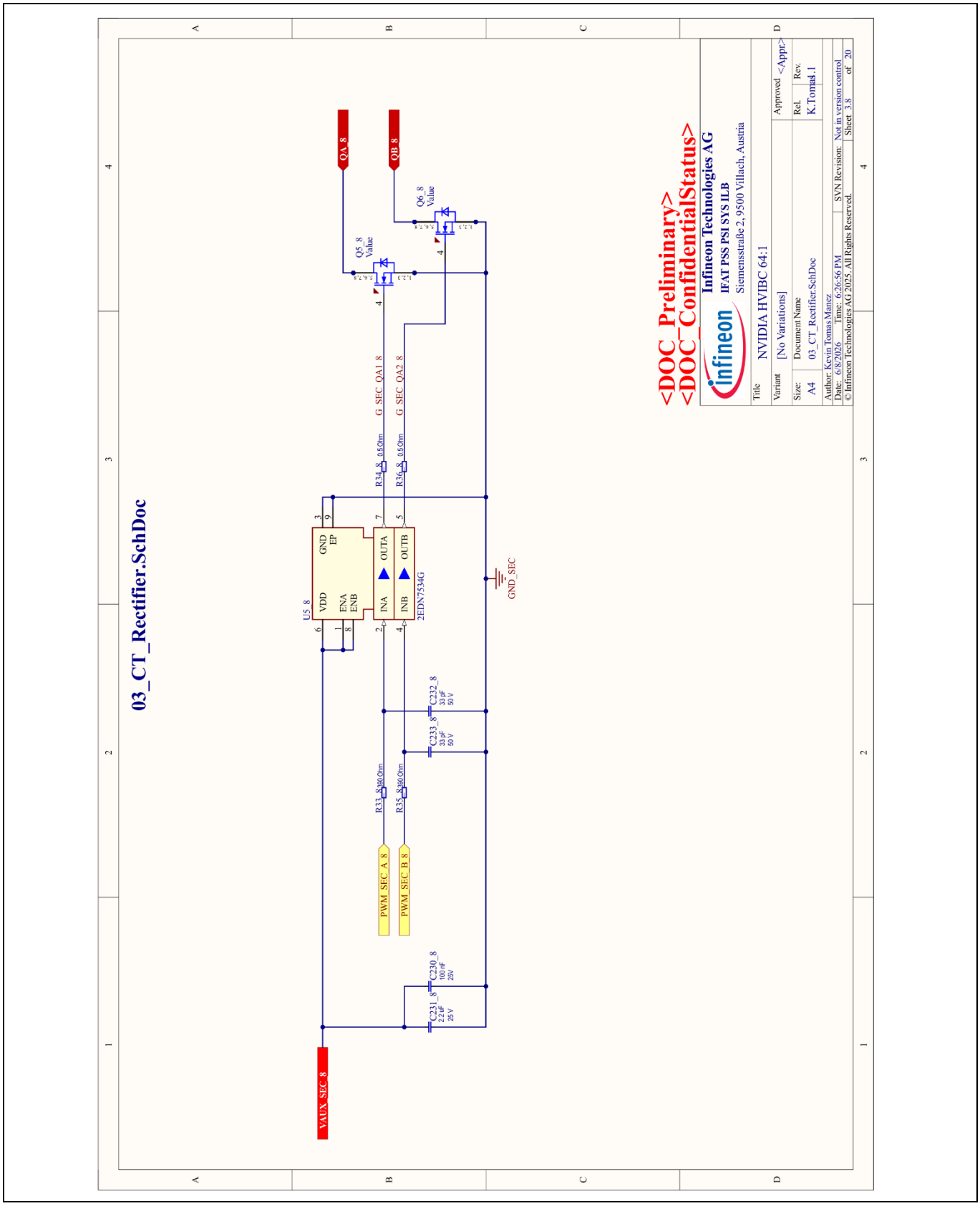



**Figure 28 CT rectifier 8**

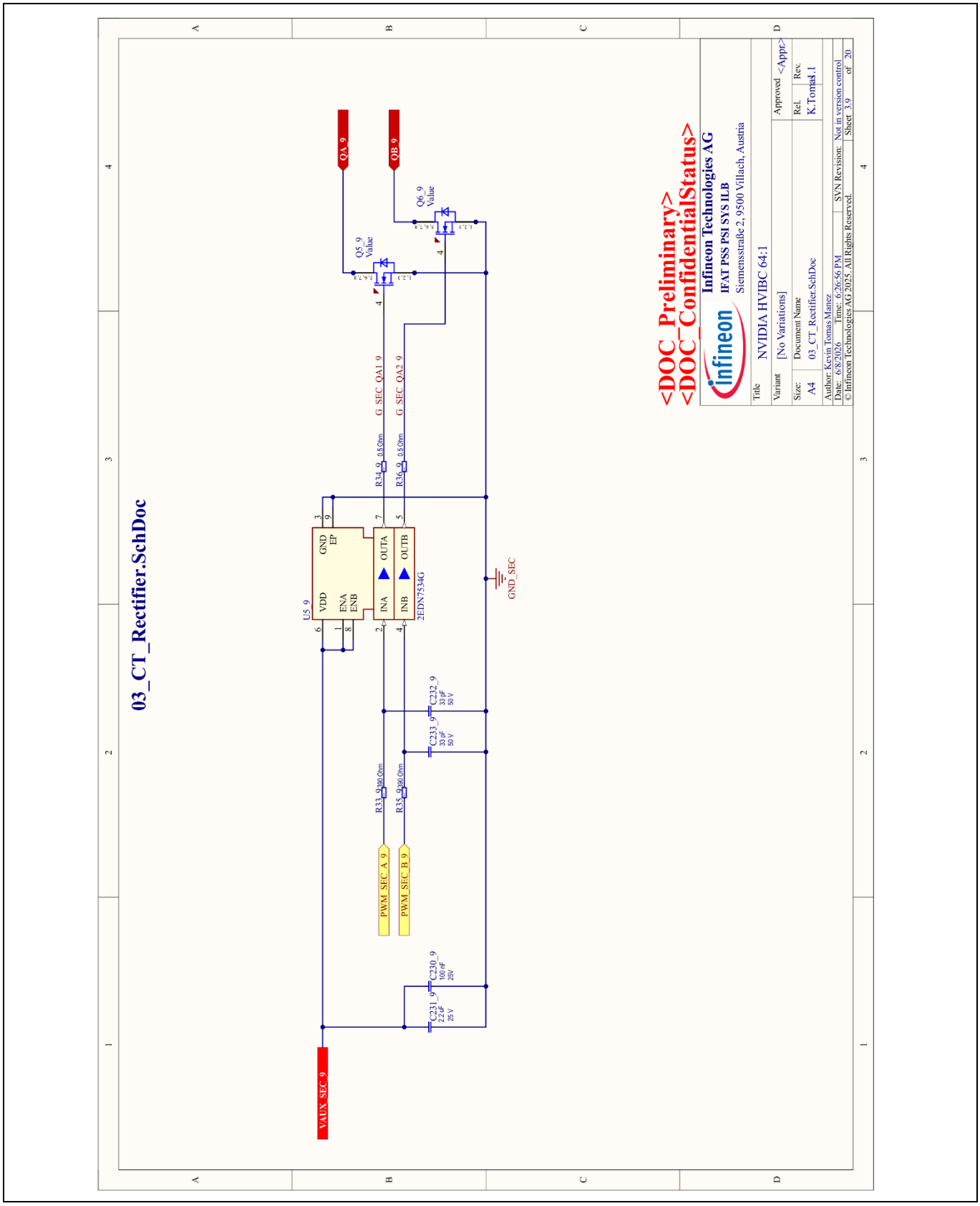



**Figure 29 CT rectifier 9**

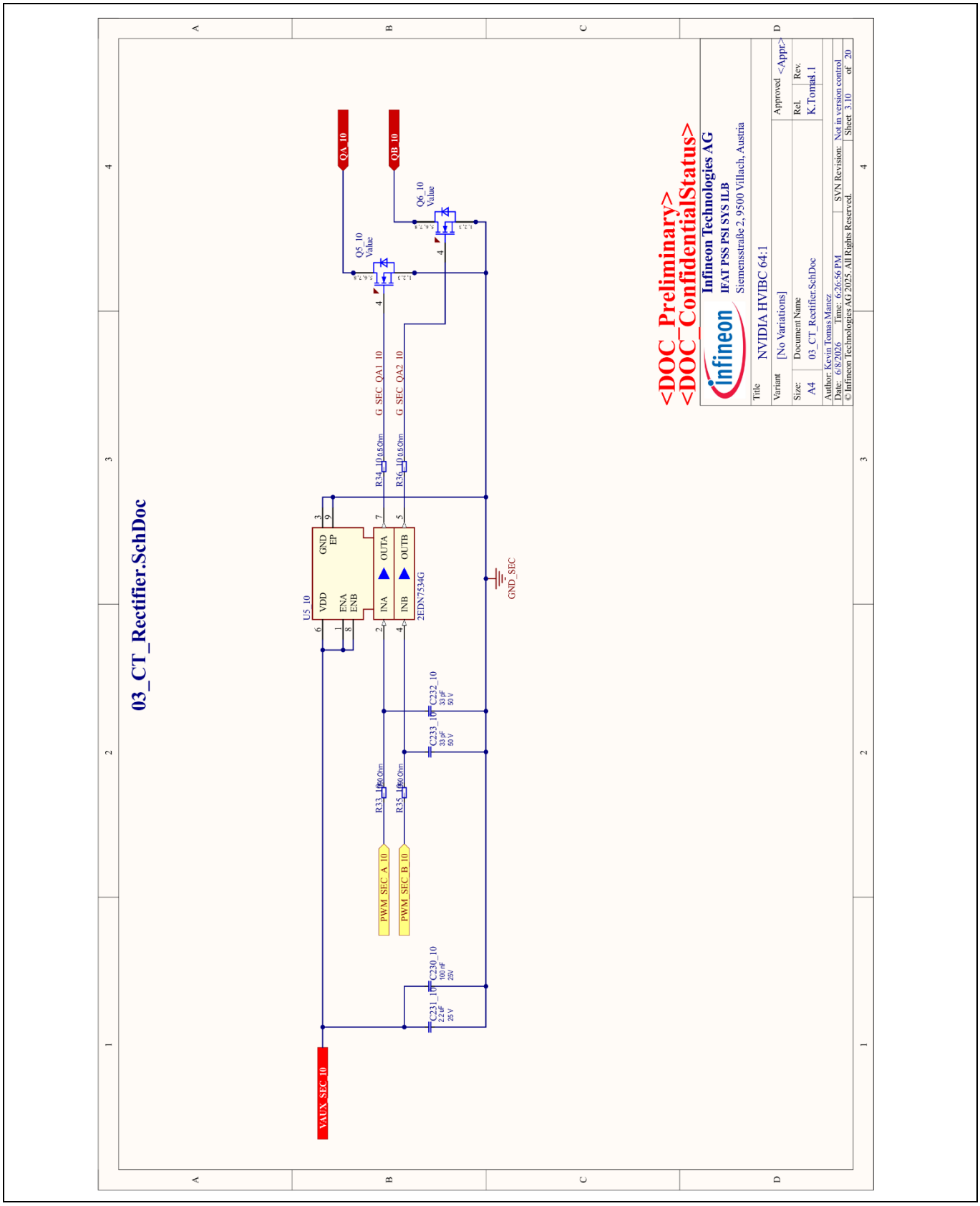



**Figure 30 CT rectifier 10**

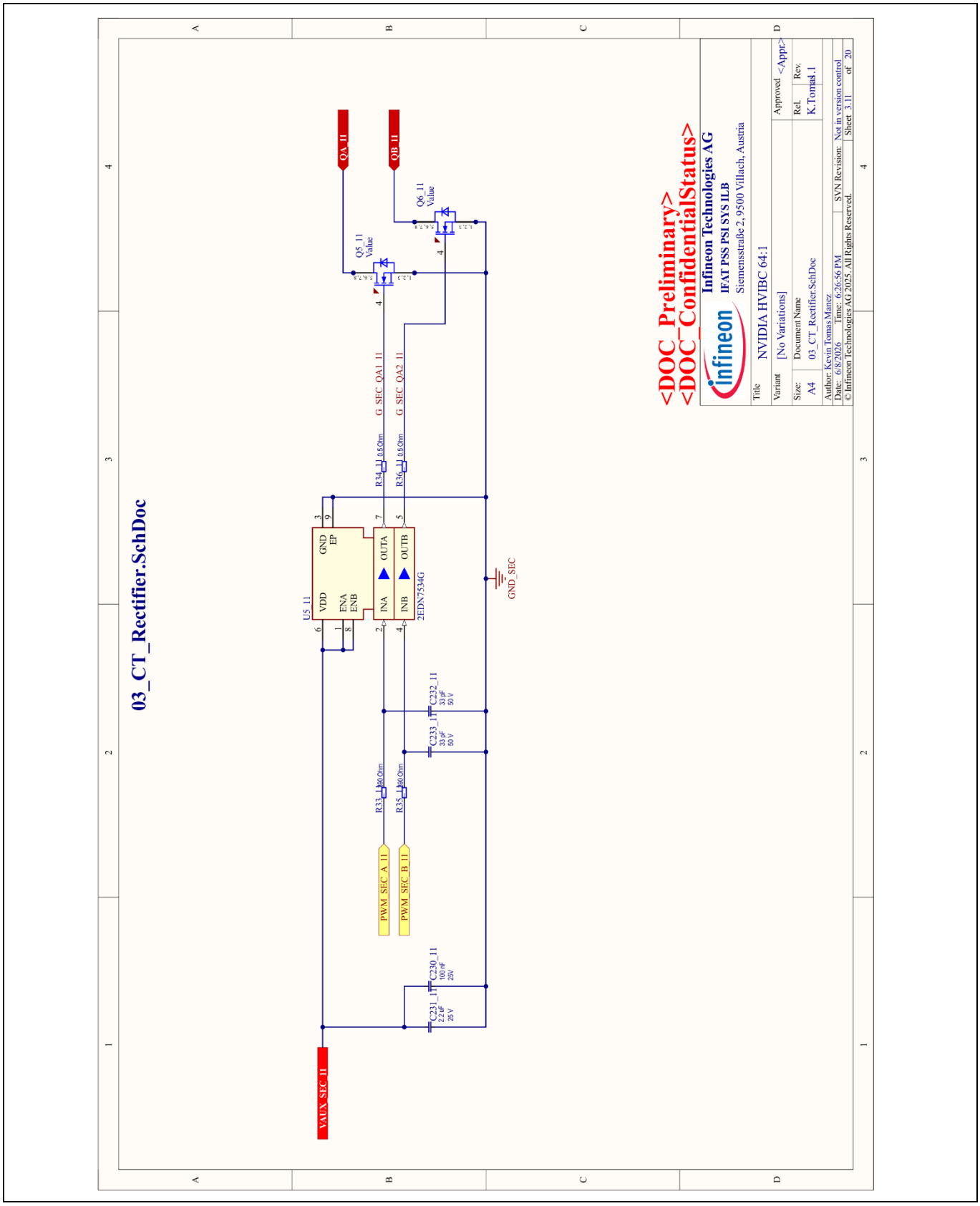



**Figure 31 CT rectifier 11**

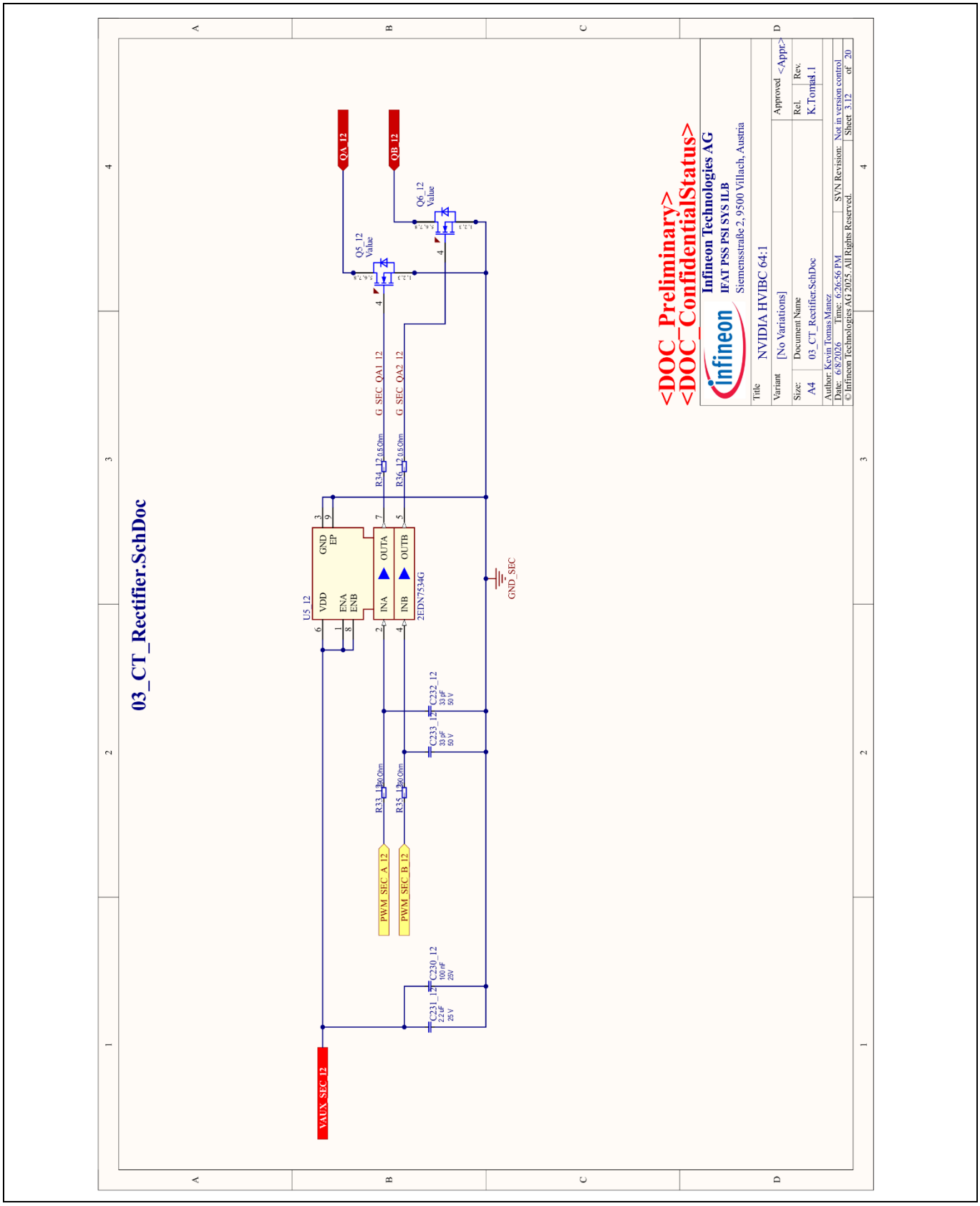



**Figure 32 CT rectifier 12**

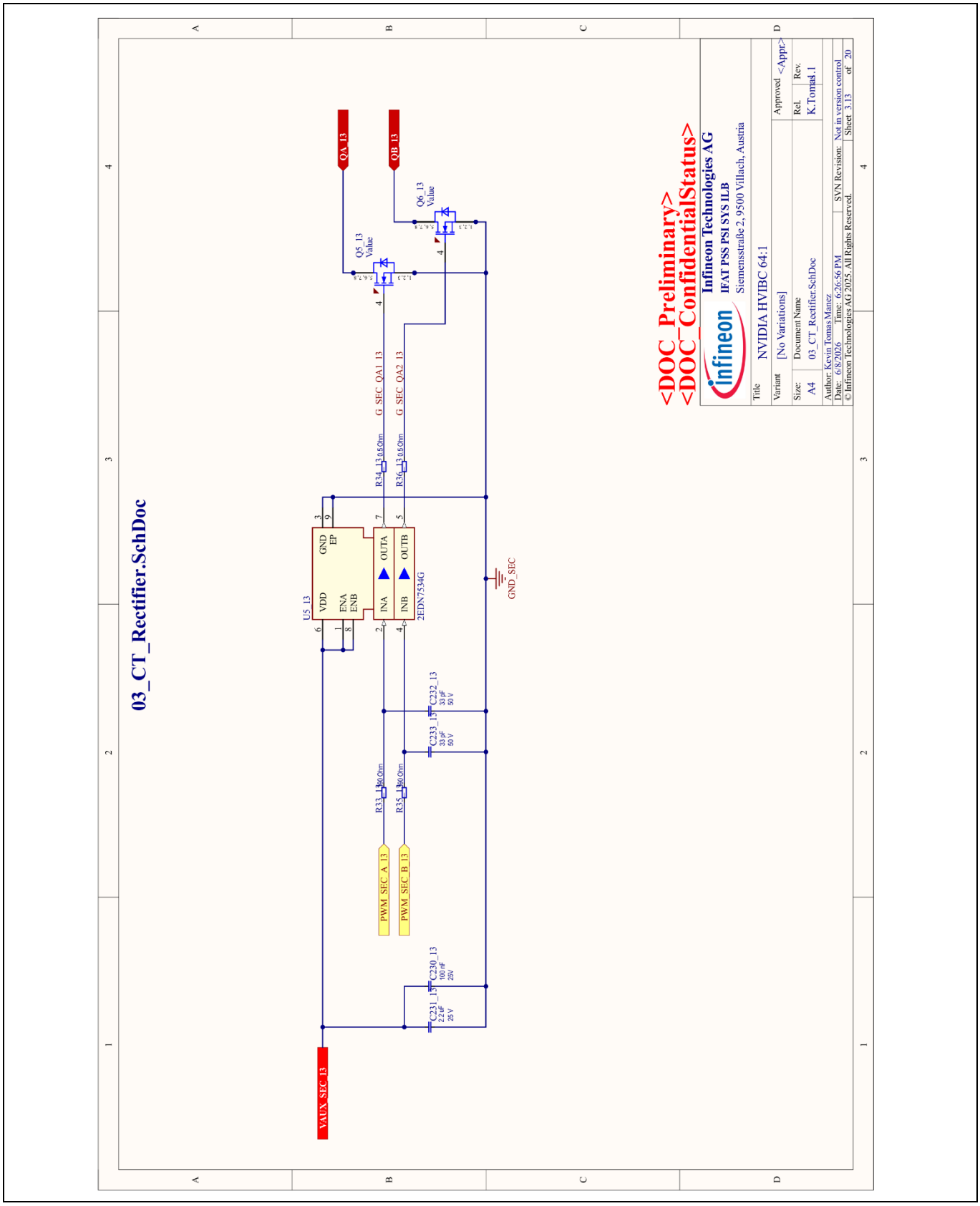



**Figure 33 CT rectifier 13**

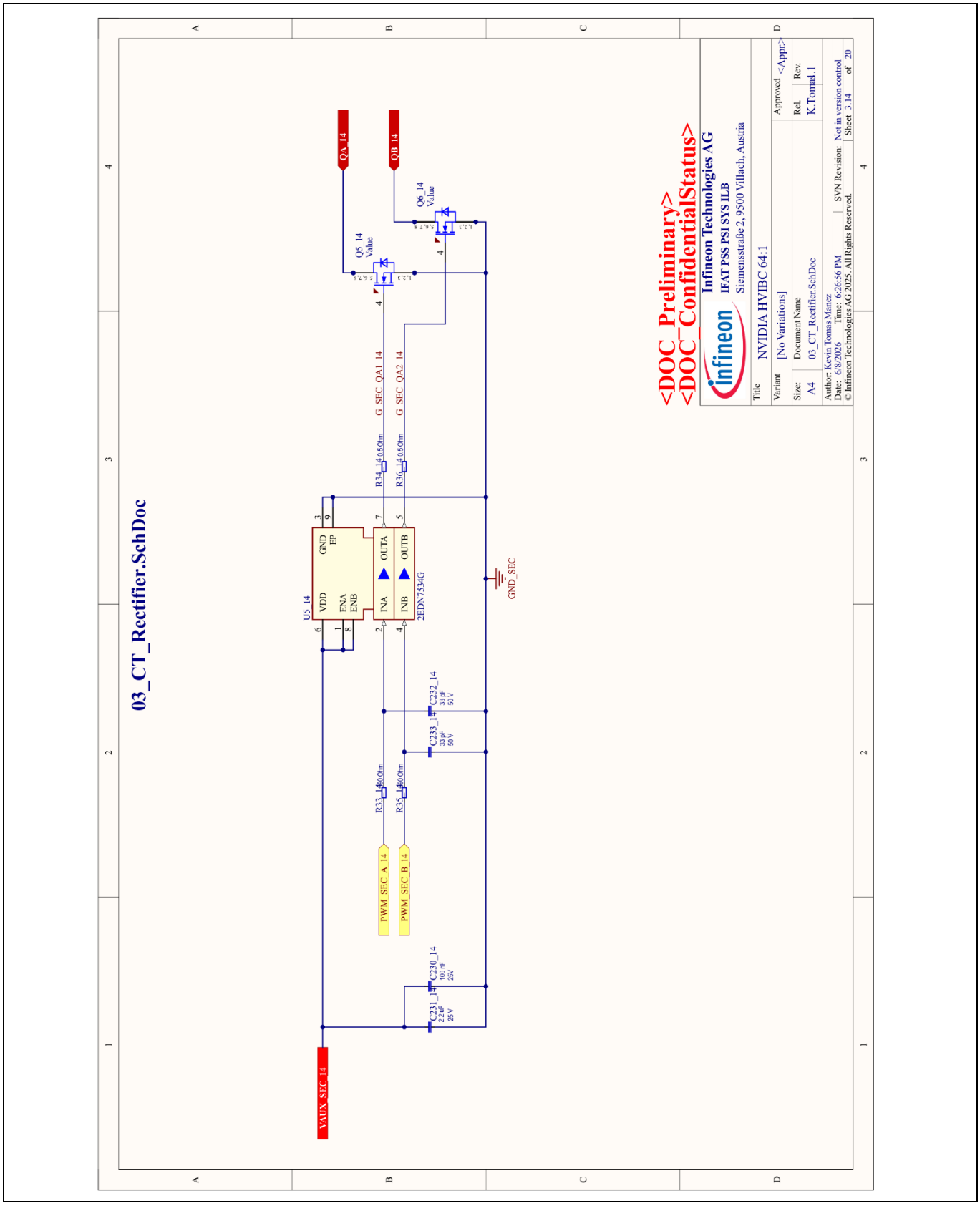



**Figure 34 CT rectifier 14**

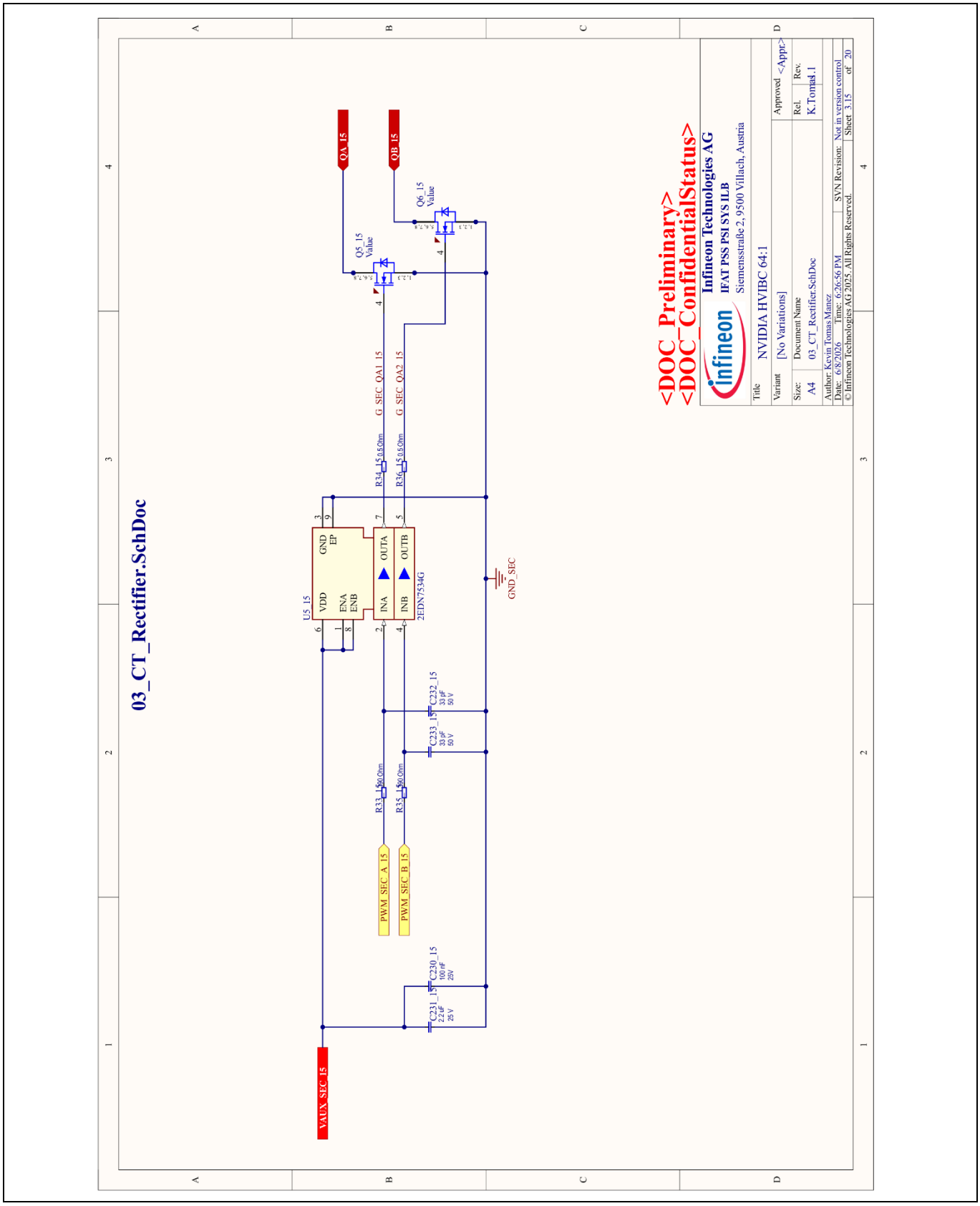



**Figure 35 CT rectifier 15**

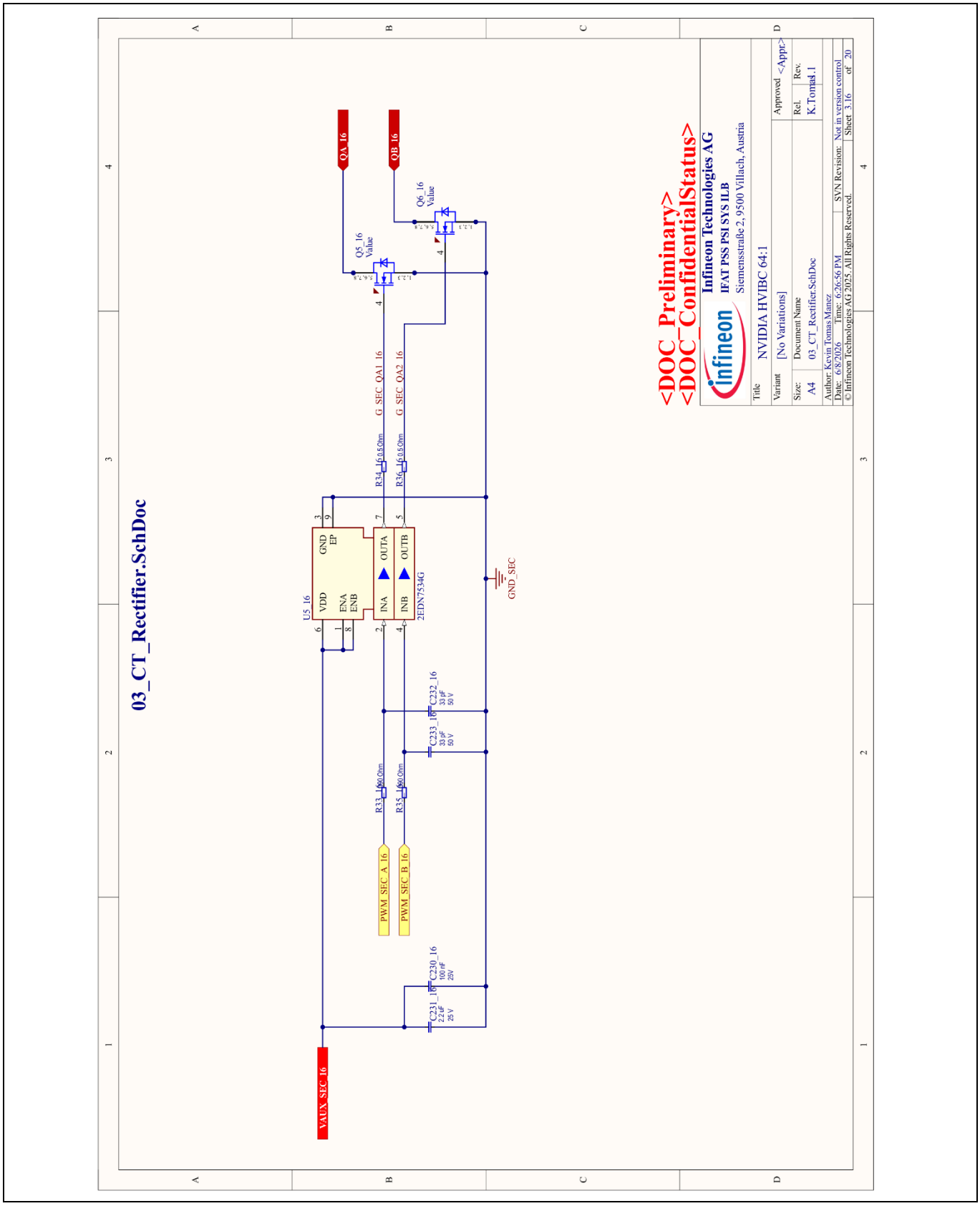



**Figure 36 CT rectifier 16**

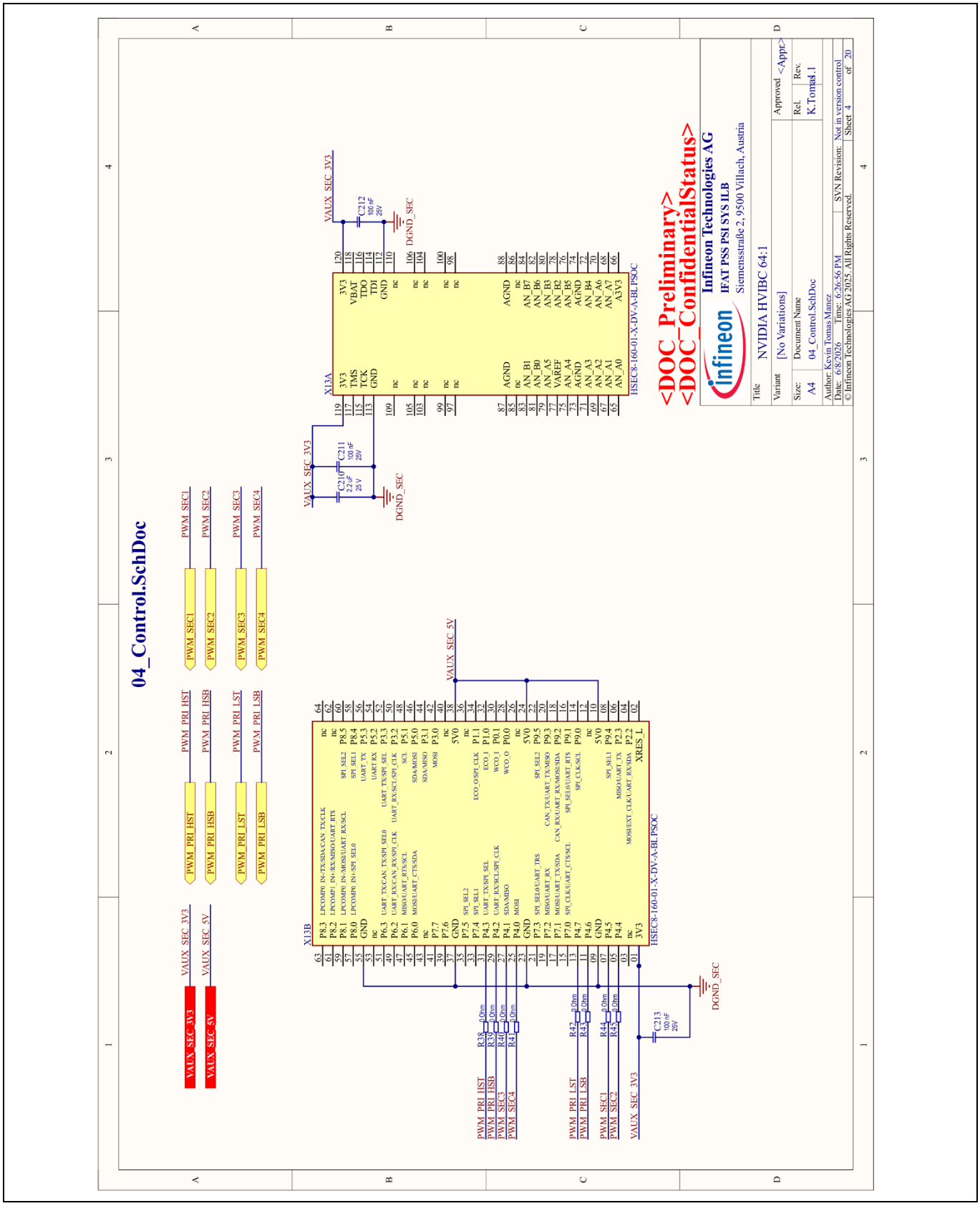



**Figure 37 Control card**

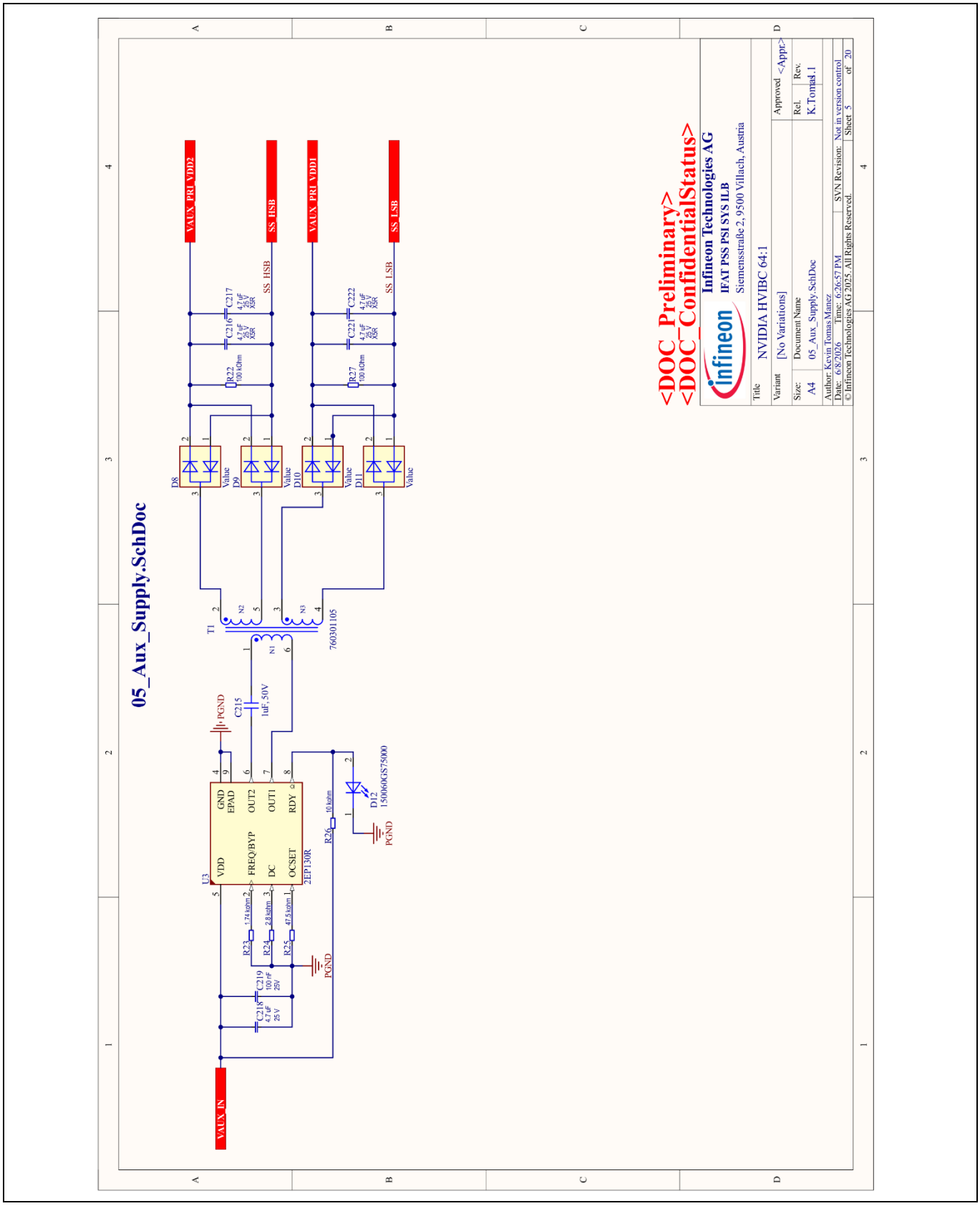



**Figure 38 Auxiliary power**

# 6 Bill of materials (BOM)

The complete bill of materials is available on the download section of the board webpage. A log-in is required to download this BOM.

**Table 6 BOM for the REF_6KW_800V_12V_IBC**

| Designator | Description | Vendor | Qty |
|---|---|---|---|
| C1, C229 | CAP / Aluminum Polymer / 22 µF / 35 V / ±20% / 35 mΩ / −55°C to +125°C / SMD, 5 × 5.9 mm | Panasonic | 2 |
| C2, C3, C4, C5, C6, C7, C8, C9 | CAP / Aluminum Hybrid Polymer / 270 µF / 35 V / ±20% / 16 mΩ / −40°C to +125°C / Radial, Ø10 × 9 mm | Panasonic | 8 |
| C10, C11, C12, C13, C14, C15, C16, C17, C18, C25, C26, C27, C28, C29, C30, C31, C32, C33, C40, C41, C42, C43, C44, C45, C46, C47, C48, C55, C56, C57, C58, C59, C60, C61, C62, C63, C70, C71, C72, C73, C74, C75, C76, C77, C78, C85, C86, C87, C88, C89, C90, C91, C92, C93, C100, C101, C102, C103, C104, C105, C106, C107, C108, C109, C110, C111, C112, C113, C114, C115, C116, C117, C118, C119, C120, C121, C122, C123, C124, C125, C126, C127, C128, C129, C130, C131, C132, C133, C134, C135, C136, C137, C138, C139, C140, C141, C142, C143, C144, C145, C146, C147, C148, C149, C150, C151, C152, C153, C154, C155, C156, C157, C158, C159, C160, C161, C162, C166, C167, C168, C169, C170, C171, C172, C173, C174, C180, C181, C182, C183, C184, C185, C186, C187, C188, C191, C192, C193, C194, C195, C196, C197, C198, C199 | CAP / CERA / 10 µF / 25 V / ±10% / X7R / −55°C to +125°C / 0805 (2012) / SMD | Murata | 144 |
| C19, C20, C21, C22, C23, C24, C49, C50, C51, C52, C53, C54, | CAP / CERA / 22 nF / 630 V / ±1% / C0G (NP0) / −55°C to +125°C / 1210 (3225) / SMD | Murata | 24 |

| Designator | Description | Vendor | Qty |
|---|---|---|---|
| C64, C65, C66, C67, C68, C69, C94, C95, C96, C97, C98, C99 | | | |
| C34, C35, C36, C37, C38, C39, C79, C80, C81, C82, C83, C84 | CAP / CERA / 1 µF / 630 V / ±10% / X7R / -55°C to +125°C / 2220 (5750) / SMD | Würth Elektronik | 12 |
| C163, C176, C177, C200, C204, C208, C210, C231_1, C231_2, C231_3, C231_4, C231_5, C231_6, C231_7, C231_8, C231_9, C231_10, C231_11, C231_12, C231_13, C231_14, C231_15, C231_16 | CAP / CERA / 2.2 µF / 25 V / ±20% / X6S / -55°C to +105°C / 0402 (1005) / SMD | Murata | 23 |
| C164, C175, C178, C201, C203, C209, C211, C212, C213, C219, C230_1, C230_2, C230_3, C230_4, C230_5, C230_6, C230_7, C230_8, C230_9, C230_10, C230_11, C230_12, C230_13, C230_14, C230_15, C230_16 | CAP / CERA / 100 nF / 25 V / ±10% / X7R / -55°C to +125°C / 0402 (1005) / SMD | Murata | 26 |
| C165, C179, C202, C207 | CAP / CERA / 5.6 nF / 50 V / ±20% / X7R / -55°C to +125°C / 0402 (1005) / SMD | Murata | 4 |
| C189, C190, C205, C206, C232_1, C232_2, C232_3, C232_4, C232_5, C232_6, C232_7, C232_8, C232_9, C232_10, C232_11, C232_12, C232_13, C232_14, C232_15, C232_16, C233_1, C233_2, C233_3, C233_4, C233_5, C233_6, C233_7, C233_8, C233_9, C233_10, C233_11, C233_12, C233_13, C233_14, C233_15, C233_16 | CAP / CERA / 33 pF / 50 V / ±1% / C0G (NP0) / -55°C to +125°C / 0402 (1005) / SMD | Murata | 36 |
| C215 | CAP / CERA / 1 µF / 50 V / ±10% / X7R / -55°C to +125°C / 0805 (2012) / SMD | Samsung | 1 |
| C216, C217, C218, C221, C222 | CAP / CERA / 4.7 µF / 25 V / ±10% / X5R / -55°C to +85°C / 0603 (1608) / SMD | Kyocera | 5 |
| D1, D12 | 150060GS75000<br>LED / Green / 520 nm / 3.2 V / 20 mA / 430 mcd / -40°C to +85°C / 0603 (1608) / SMD | Würth Elektronik | 2 |
| D2, D4, D5, D7 | PMEG2010AEB,115<br>DIODE / Schottky / 20 V / 1 A / 620 mV / -65°C to +150°C / SOD-523-2 / SMD | Nexperia | 4 |
| D3, D6 | VS-3C02EJ07-M3/H<br>DIODE / SiC Schottky / 650 V / 2 A / 1.5 V / -55°C to +175°C / DO-221AC-2 / SMD | Vishay | 2 |

| Designator | Description | Vendor | Qty |
|---|---|---|---|
| D8, D9, D10, D11 | BAT54-04W<br>DIODE / Schottky (Dual Series) / 30 V / 200 mA / 800 mV / -65°C to +150°C / SOT-323-3 / SMD | Infineon Technologies | 4 |
| Q1, Q2, Q3, Q4 | IGLT65R025D2<br>FET / GaN HEMT / 650 V / 67A / 30 mΩ / 16 nC / -55°C to +15°C / SMD | Infineon Technologies | 4 |
| Q5_1, Q5_2, Q5_3, Q5_4, Q5_5, Q5_6, Q5_7, Q5_8, Q5_9, Q5_10, Q5_11, Q5_12, Q5_13, Q5_14, Q5_15, Q5_16, Q6_1, Q6_2, Q6_3, Q6_4, Q6_5, Q6_6, Q6_7, Q6_8, Q6_9, Q6_10, Q6_11, Q6_12, Q6_13, Q6_14, Q6_15, Q6_16 | ISCH69N04LM7SC<br>FET / MOSFET / 40 V / 380 A / 0.69 mΩ / 32 nC / −55°C to +175°C / SuperSO8, 5 × 6 mm (DSC) | Infineon Technologies | 32 |
| R1 | RES / Thin Film / 9.1 kΩ / ±1% / 100 mW / 50 ppm/°C / −55°C to +125°C / 0603 (1608) / SMD | Vishay | 1 |
| R3, R17 | RES / Thick Film / 0 Ω / 125 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Vishay | 2 |
| R4, R7, R15, R20 | RES / Thick Film / 330 Ω / ±1% / 125 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Vishay | 4 |
| R5, R6, R13, R19 | RES / Thick Film / 4.7 Ω / ±1% / 125 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Vishay | 4 |
| R8, R9, R12, R14 | RES / Thick Film / 390 Ω / ±1% / 100 mW / 100 ppm/°C / −55°C to +155°C / 0402 (1005) / SMD | Vishay | 4 |
| R10, R11, R16, R18, R21 | RES / Thick Film / 0 Ω / 100 mW / −55°C to +155°C / 0402 (1005) / SMD | Vishay | 5 |
| R22 | RES / Thin Film / 100 kΩ / ±0.05% / 100 mW / 10 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Panasonic | 1 |
| R23 | RES / Thick Film / 1.74 kΩ / ±1% / 100 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | YAGEO | 1 |
| R24 | RES / Thick Film / 2.8 kΩ / ±1% / 100 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | YAGEO | 1 |
| R25 | RES / Thin Film / 47.5 kΩ / ±1% / 100 mW / 50 ppm/°C / −55°C to +125°C / 0603 (1608) / SMD | Vishay | 1 |
| R26 | RES / Thick Film / 10 kΩ / ±1% / 100 mW / 100 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Panasonic | 1 |
| R27 | RES / Thin Film / 100 kΩ / ±0.05% / 100 mW / 10 ppm/°C / −55°C to +155°C / 0603 (1608) / SMD | Panasonic | 1 |
| R33_1, R33_2, R33_3, R33_4, R33_5, R33_6, R33_7, R33_8, R33_9, R33_10, R33_11, R33_12, R33_13, R33_14, R33_15, R33_16, R35_1, R35_2, R35_3, R35_4, R35_5, | RES / Thick Film / 390 Ω / ±1% / 100 mW / 100 ppm/°C / −55°C to +155°C / 0402 (1005) / SMD | Vishay | 32 |

| Designator | Description | Vendor | Qty |
|---|---|---|---|
| R35_6, R35_7, R35_8, R35_9, R35_10, R35_11, R35_12, R35_13, R35_14, R35_15, R35_16 | | | |
| R34_1, R34_2, R34_3, R34_4, R34_5, R34_6, R34_7, R34_8, R34_9, R34_10, R34_11, R34_12, R34_13, R34_14, R34_15, R34_16, R36_1, R36_2, R36_3, R36_4, R36_5, R36_6, R36_7, R36_8, R36_9, R36_10, R36_11, R36_12, R36_13, R36_14, R36_15, R36_16 | RES / Thick Film / 500 mΩ / ±5% / 62.5 mW / 300 ppm/°C / −55°C to +155°C / 0402 (1005) / SMD | YAGEO | 32 |
| R38, R39, R40, R41, R42, R43, R44, R45 | RES / Thick Film / 0 Ω / 250 mW / −55°C to +155°C / 0805 (2012) / SMD | Vishay | 8 |
| T1 | XFMR / Gate Drive Transformer / 1:1 / 260 µH / 1.5 kV Isolation / −40°C to +125°C / 8.5 × 7 × 6 mm / SMD | Würth Elektronik | 1 |
| TP*1, TP*2, TP*3, TP*4, TP*5, TP*6 | TP / Test Point / Red / Phosphor Bronze / 8.89 mm / Through-Hole | Keystone Electronics | 6 |
| TP*15, TP*16 | TP / Test Point / Multipurpose / 11.3 mm / Through-Hole | Keystone Electronics | 2 |
| U1, U2 | 2EDR7259X<br>IC / Isolated Gate Driver / 2 Channel / 5 A Source / 9 A Sink / 38 ns / SOIC-14N | Infineon Technologies | 2 |
| U3 | 2EP130R<br>IC / Full-Bridge Gate Driver / 2 Channel / 15 ns Rise/Fall Time / 340 ns / TSSOP-8 | Infineon Technologies | 1 |
| U5_1, U5_2, U5_3, U5_4, U5_5, U5_6, U5_7, U5_8, U5_9, U5_10, U5_11, U5_12, U5_13, U5_14, U5_15, U5_16 | 2EDN7534G<br>IC / Low-Side Gate Driver / 2 Channel / 5 A / 25 ns / TSSOP-8 | Infineon Technologies | 16 |
| X1, X2 | 74655095R<br>TERM / Screw Terminal / M5 / 85 A / Brass, Tin-Plated / −55°C to +150°C / Through-Hole | Würth Elektronik | 2 |
| X3, X10 | 691322110002<br>CONN / Pluggable Terminal Block Header / 2 Position / 3.5 mm Pitch / 10 A / 300 VAC / Right Angle / Through-Hole | Würth Elektronik | 2 |
| X4, X5, X6, X7, X8, X9, X11, X12 | 7460408<br>TERM / Press-Fit Terminal / M5 Female / 175 A / Brass, Tin-Plated / −40°C to +135°C / PCB Mount | Würth Elektronik | 8 |
| X13 | HSEC8-160-01-X-DV-A-BL | Samtec | 1 |

## Bill of materials (BOM)

| Designator | Description | Vendor | Qty |
|---|---|---|---|
| | CONN / Card Edge Socket / 120 Position / 0.8 mm Pitch / 2 Row / Vertical / SMT | | |

# References

[1] Infineon Technologies AG: IGLT65R025D2 CoolGaN™ Transistor 650 V G5 datasheet; Available online

[2] Infineon Technologies AG: EiceDRIVER™ 2EDR7259X datasheet; Available online

[3] Infineon Technologies AG: OptiMOS™ 7 power MOSFET 40 V ISCH69N04LM7SC datasheet; Available online

[4] Infineon Technologies AG: EiceDRIVER™ 2EDN7534G datasheet; Available online

[5] Infineon Technologies AG: EiceDRIVER™ 2EP130R transformer driver IC datasheet; Available online

[6] Infineon Technologies AG: Whitepaper – Gate drive configurations for GaN power transistors; Available online

[7] Infineon Technologies AG: User manual - KIT_PSC3M5_CC1; Available online

# Abbreviations and acronyms

**Table 7 Abbreviations and acronyms**

| Abbreviation | Expansion |
|---|---|
| AI | Artificial intelligence |
| AN | Application note |
| BOM | Bill of materials |
| CTSR | Center-tapped synchronous rectifier |
| EMI | Electromagnetic interference |
| ESD | Electrostatic discharge |
| GaN | Gallium nitride |
| GIT | Gate Injection transistor |
| GND | Ground |
| GPU | Graphics processing unit |
| GUI | Graphical user interface |
| HB | Half bridge |
| HV | High voltage |
| HVIBC | High-voltage intermediate bus converter |
| IBC | Intermediate bus converter |
| ISOP | Input-series output-parallel |
| LLC | Inductor-inductor-capacitor resonant converter |
| LV | Low voltage |
| MOSFET | Metal-oxide-semiconductor field-effect transistor |
| OCP | Overcurrent protection |
| OVP | Overvoltage protection |
| PCB | Printed circuit board |
| PMBus® | Power management bus |
| PPE | Personal protective equipment |
| PWM | Pulse-width modulation |
| SAE | System application engineering |
| SCP | Short-circuit protection |
| SR | Synchronous rectifier |
| TIM | Thermal interface material |
| TPU | Tensor processing unit |
| UVP | Undervoltage protection |
| ZVS | Zero-voltage switching |

# Revision history

| Document revision | Date | Description of changes |
|---|---|---|
| V 1.0 | 2026-11-19 | Initial release |

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