Eval-iSSI20R11H user guide

Board description

iSSI20R11H

Infineon's coreless-transformer advanced solid-state isolator (Infineon SSI)

About this document

This user guide describes the functionalities and key features of Infineon’s coreless-transformer advanced solid-state isolator.

Scope and purpose

The Infineon SSI solid-state isolator evaluation board EVAL-iSSI20R11H features the coreless-transformer advanced solid-state isolator, iSSI20R11H. This user guide covers the design revision 1.0 of this evaluation board.

iSSI20R11H is certified as per UL 1577 and reinforced isolation (IEC 60747-17, planned).

Intended audience

- Engineers who want to learn how to use Infineon’s SSI advanced solid-state isolator iSSI20R11H
- Experienced design engineers who design circuits with photovoltaic isolators (PVI), IGBTs, and MOSFETs
- Design engineers who develop solid-state relays

Evaluation board

The evaluation board EVAL-iSSI20R11H is designed based on environmental conditions described in this document. It has been tested as described in this document, but not qualified regarding manufacturing, lifetime, or over the full range of ambient operating conditions. The boards provided by Infineon are not subject to full production tests.

Evaluation boards are not subject to the same procedures as regular products regarding returned material analysis (RMA), process change notification (PCN), and product discontinuation (PD). Evaluation boards are intended to be used under laboratory conditions and by trained specialists only.

Note: The printed circuit board (PCB) and auxiliary circuits are NOT optimized for final customer design.

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Safety precautions

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

Table 1 Safety precautions

	**Warning:** *The DC link potential of this board is up to 1000 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
	**Warning:** *The evaluation or reference board 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.*
	**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:** *An evaluation board that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the load, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*
	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*

Table of contents

1 Overview and key features

EVAL-iSSI20R11H is intended for evaluating the product features of Infineon's SSI solid-state isolator, iSSI20R11H, in an application circuit. The key features of the board and the iSSI20R11H are as follows:

- Evaluation board with iSSI20R11H and two CoolMOS™ IPT60R065S7 MOSFETs in an AC switch configuration
- Ultra-fast overcurrent detection that is triggered at the typical peak current of 9 A
- Over-temperature protection with PTC resistor (optional).
- Fast turn-on
- Fast turn-off after overcurrent and over-temperature protection

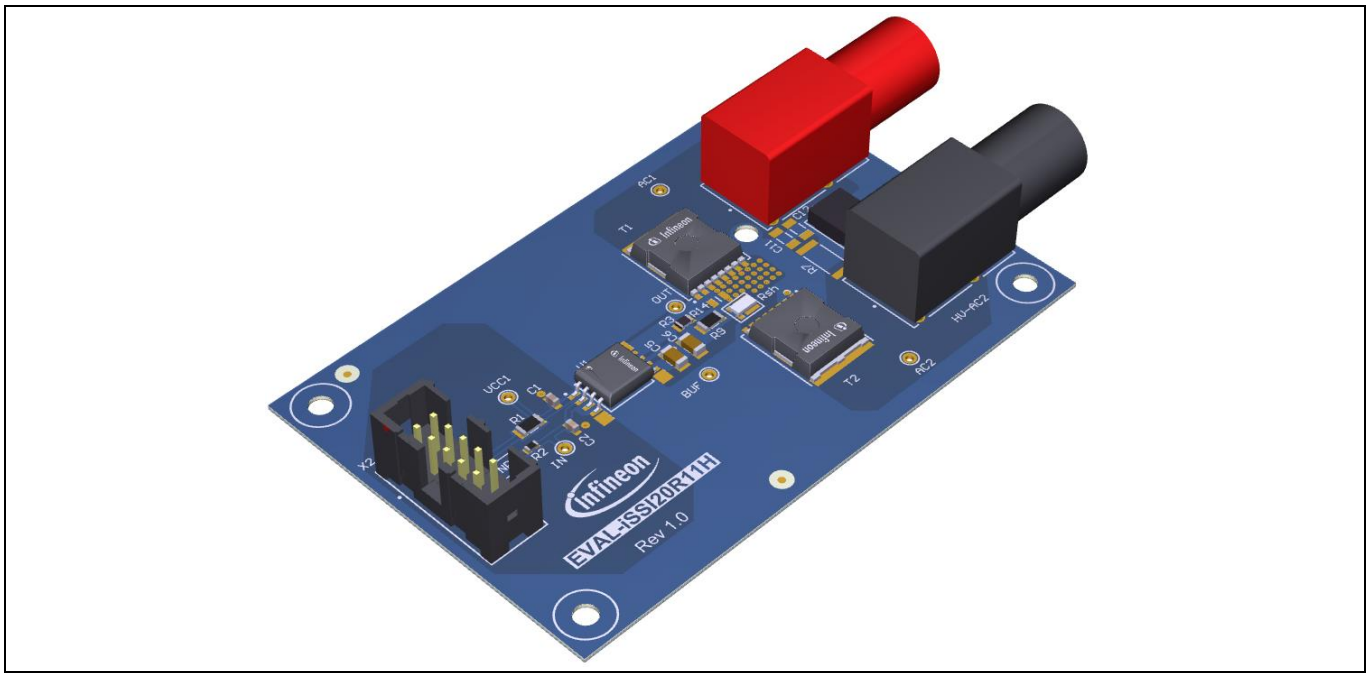

Figure 1 The EVAL-iSSI20R11H evaluation board

This board is best suited for testing the switching performance of Infineon SSI and CoolMOS™ S7 as described in Chapter 3. It requires additional considerations about thermal and power balance for continuous operation.

The control interface can be connected to a pulse generator, a microcontroller, or other digital circuits with appropriate driving capability of at least 25 mA.

2 Absolute maximum ratings, operating conditions, and supply voltages

Some components on the evaluation boards as well as the Infineon SSI solid-state isolator have defined operating conditions and maximum ratings to avoid damage to individual parts and the overall evaluation board.

Table 2 Absolute maximum ratings

Pin name / parameter	Connector / symbol	Min	Max	Unit	Note
VSUP	*X2.1, X2.2*	-10	3.6	V	Input, Infineon SSI solid-state isolator voltage supply
INP	*X2.5, X2.6*	-10	15	V	Input, digital signal
HV-AC1 *HV-AC2*	*HV-AC1* *HV-AC2*	-320	320	V	Input, high-voltage power supply. For 42 V and above, special high-voltage lab environment is strongly recommended
RMS current	*HV-AC1/2*	-	2	A	
DC current	*HV-AC1/2*	-	2	A	
AC1 peak current *AC2 peak current*	*HV-AC1* *HV-AC2*	-	9	A	Phase peak current for overcurrent protection test (t_{pulse} < 20µs)
Switching frequency	f_{sw}	-	1	Hz	Maximum switching frequency for continuous operation. Power dissipation required for power transistor and Infineon SSI solid-state isolator has been carefully considered
Ambient temperature	T_a	-	30	°C	

The printed circuit board (PCB) assembly is optimized for a *VSUP* voltage supply of 3.3 V. Higher supply voltages may require adjustments to the current limiting resistor, R1.

Table 3 Operating conditions and supply voltages

Pin name / parameter	Min.	Typ.	Max.	Unit	Note
VSUP	2.5	3.3	3.5	V	Input voltage supply
INP	0	-	3.3	V	Input, digital signal
HV-AC1	-320	-	320	V	Input, high-voltage power supply, referenced to *HV-AC2*. For 42 V and above, special high-voltage lab environment is strongly recommended
Inductive load	-	-	300	µH	
Ambient temperature	-	25	30	°C	

3 Getting started with EVAL-iSSI20R11H

Follow the steps given in this chapter to set up and power up the board, and to perform initial evaluations.

Prerequisites

- Have a low-voltage supply ready for the input supply voltage, *VSUP*, with a current capability of at least 25 mA for *VSUP*
- Have a power supply, V_{HV}, in series with a suitable load, Z_{Load}, ready to connect *HV-AC1* and *HV-AC2*
- Have a function generator ready for control signal input, *INP*

To adapt the circuit to application requirements, resistor or capacitor values can be changed to optimize performance.

Steps to power up the board

1. Connect the supply voltage, *VSUP,* to connector *X2.1* with +3.3 V and the ground, *GND*, to connector *X2.7*.
2. Connect the digital pulse-width modulation (PWM) generator to input signal connector *X2.5* and *GND* to connector *X2.9*. Make sure that the outputs of the PWM generator are disabled, or the signals are set to low.
3. Connect the power supply, V_{HV}, to connector *HV-AC1.*
4. Connect the ground of power supply, V_{HV}, to one end of the load, Z_{Load}, and the other end to connector *HV-AC2*.
5. The board is now ready to evaluate switching.

Steps to safely power down the board

6. Turn off the power supply, V_{HV}.
7. Discharge the DC-link capacitor (if available) and check the DC-link voltage with, e.g., a digital multimeter or an oscilloscope (for DC operation).
8. Turn off the low-voltage supply.

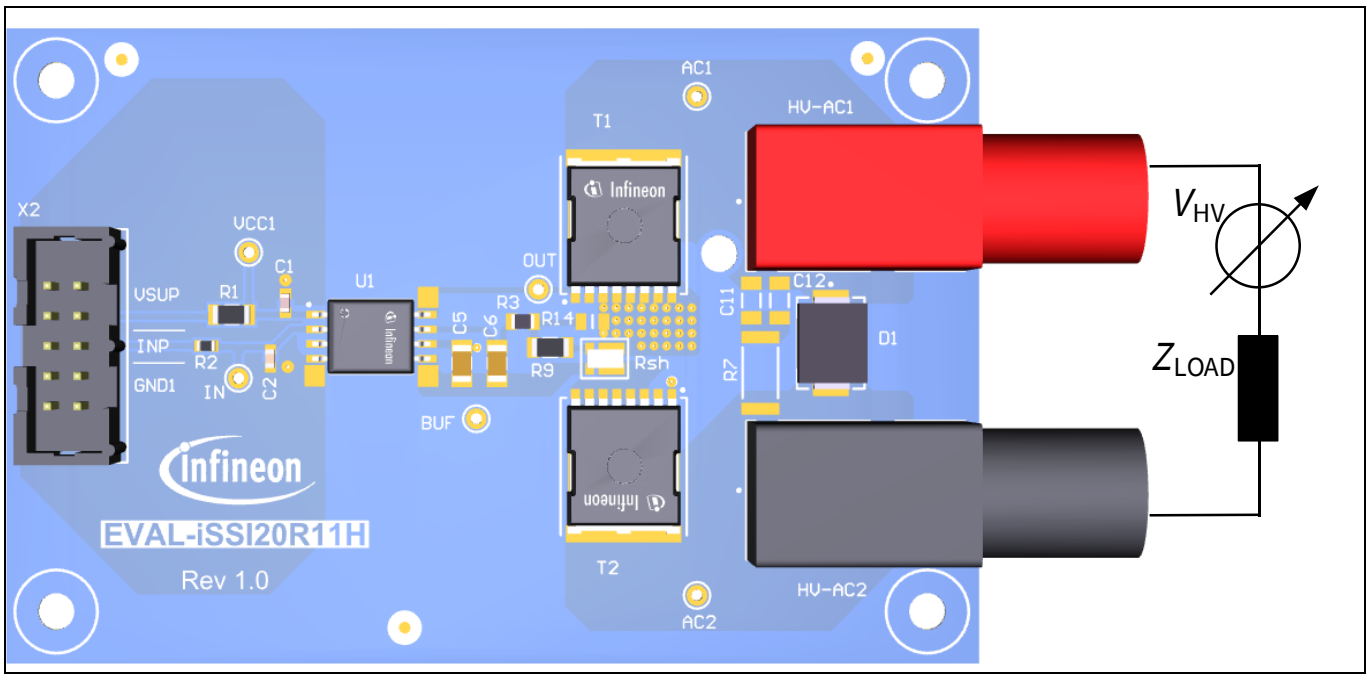

Figure 2 Connection of load, Z_{Load} , for tests

3.1 Overcurrent protection

The detection circuit monitors the voltage across shunt resistor, Rsh. This signal passes a noise RC filter, consisting of R3 and C6. The integrated comparator of the SSI compares it to a fixed threshold voltage $|V_{CS,th}|$ at terminal *CS* of iSSI20R11H. The maximum peak current can be adapted to application requirements by changing the shunt resistor, Rsh, using the following equation:

$$Rsh = \frac{V_{\mathrm{CS,th}}}{I_{\mathrm{pk,max}}}$$

Once triggered, the protection reacts quickly and is able to turn off, for example, CoolMOS™ IPT60R065S7 in a very short time. Thus, it is able to support AC-15 system tests as per IEC 60947-5-1 guidelines under appropriate operating conditions.

The triggering of overcurrent protection leads to the latched turn-off of the power switch with a sinking current, $I_{off,\ fast,sat}$. To return to normal operation, applying either 0 V to *VSUP* or a low signal at the logic control input, *INP*, is required.

3.2 Over-temperature protection (optional)

The over-temperature feature is not given by default. iSSI20R11H provides a constant bias current, $I_{TS,bias}$, biasing a PTC resistor. The constant current generates a voltage at the PTC that is connected to terminal TS, and the terminal voltage is compared to the threshold voltage $V_{TS,th}$. The integrated comparator includes a noise filter of duration $t_{TS,filter}$ for safely detecting the sensor signal. This noise filter is complemented by an external RC filter (R4, C7).

Once triggered, the protection reacts quickly and is able to turn off, for example, CoolMOS™ IPT60R065S7 in a very short time. The triggering of the over-temperature protection leads to the latched turn-off of the power switch with a sinking current of $I_{off,\ fast,sat}$. To return to normal operation, applying either 0 V to *VSUP* or a low signal at the logic control input, *INP,* is required.

The triggering of the over-temperature protection can be forced by externally heating of the temperature sensor, as well.

3.3 Connectors and pin assignment

Table 4 Connectors and pin assignment

Connector	Pin	Marking/ function	Note
X2	1, 2, 3, 4 5, 6 7, 8, 9, 10	*VSUP* *INP* *GND1*	Infineon SSI solid-state isolator voltage supply Infineon SSI solid-state isolator input signal /INF Infineon SSI solid-state isolator voltagee supply reference
HV-AC1	1	*HV-AC1*	High-voltage power supply
HV-AC2	1	*HV-AC2*	High-voltage power supply

3.4 Board options

The evaluation board offers functional options implemented by parts that are not populated. These options are:

- Realization of a snubber circuit (C11, C12, R7)
- Implement an over-temperature protection using PTC resistor R14. This option requires the following actions:
    - short shunt resistor Rsh
    - depopulate resistor R9
    - populate PTC resistor R14

4 Schematic diagram

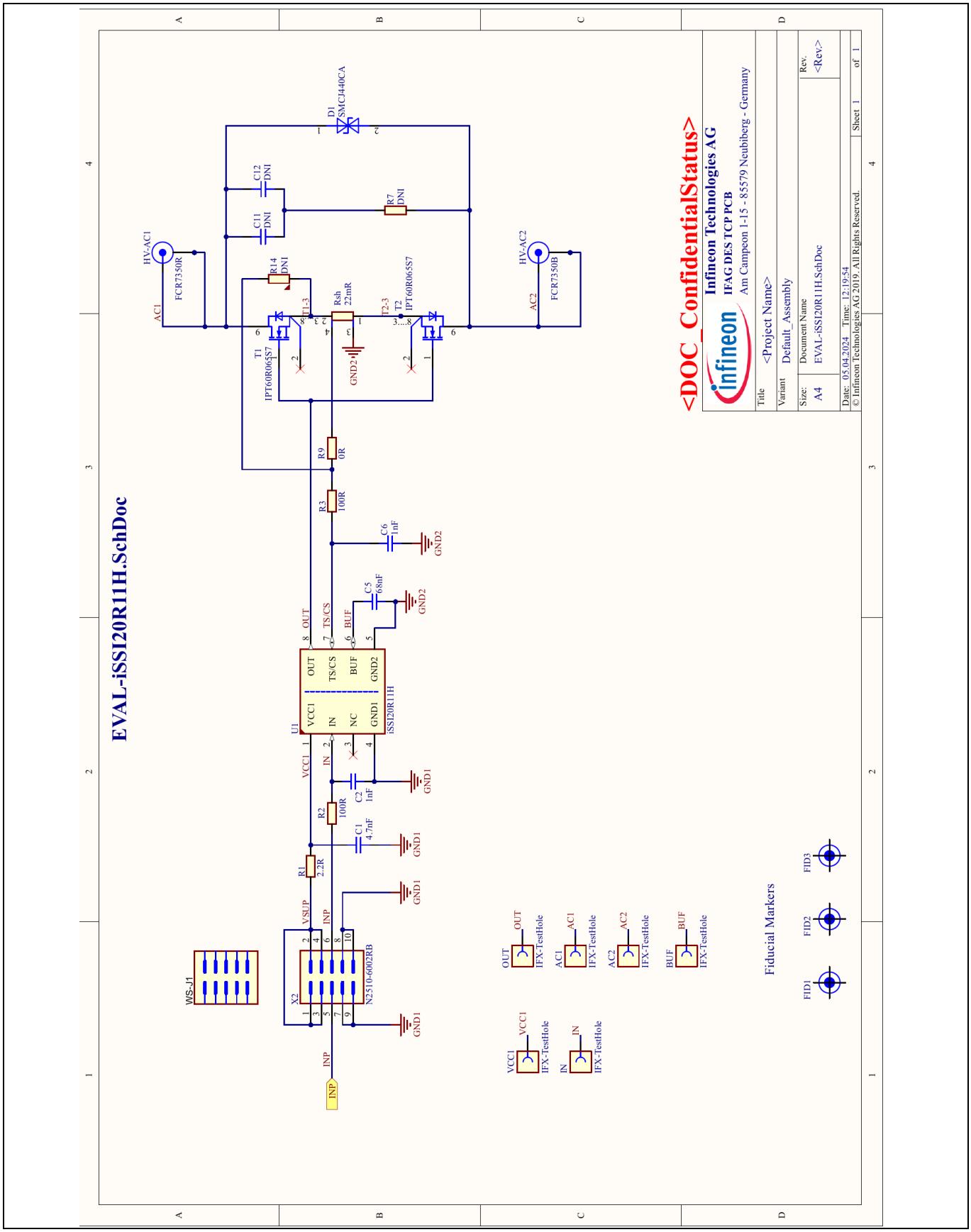

Figure 3 Schematics of Eval-iSSI20R11H (assembled components only)

5 Layout

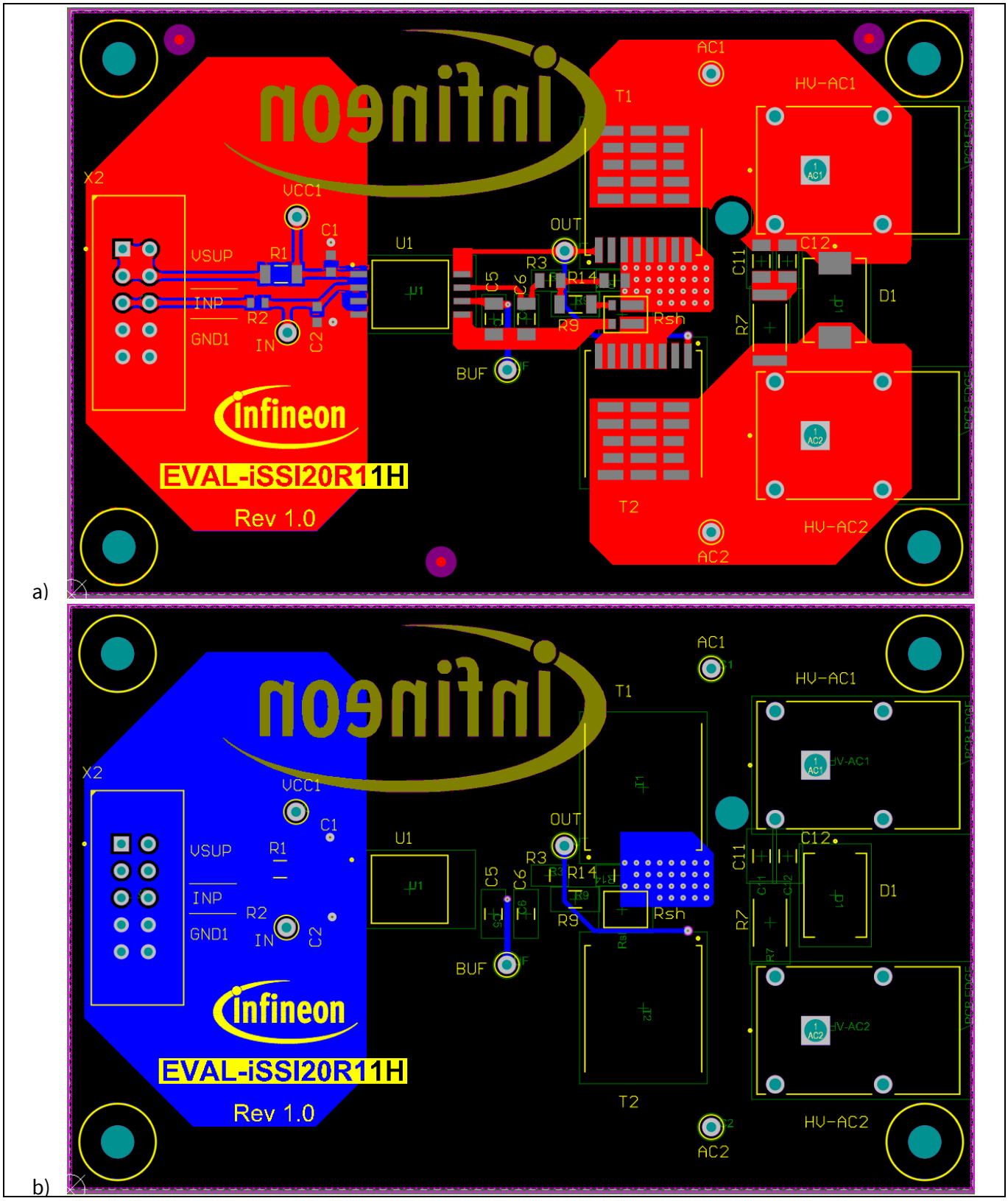

Figure 4 Top (a) and bottom (b) layers of Eval-iSSI20R11H

6 Bill of materials

Table 5 Eval-iSSI20R11H bill of materials

Component	Value	Description	Manufacturer	Part number
C1	4.7nF	CAP / CERA / 4.7nF / 25V / 10% / X7R (EIA) / -55°C to 125°C / 0603(1608) / SMD / -	MuRata	GRM188R71E472KA01
C2	1nF	CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 0603(1608) / SMD / -	Wurth Elektronik	885012206083'
C5	68nF	CAP / CERA / 68nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 1206(3216) / SMD / -	MuRata	GRM319R71H683KA01
C6	1nF	CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 1206(3216) / SMD / -	MuRata	GRM319R71H102KA01
D1	SMCJ440CA	Surface Mount TVS Diode, 440V, 2kW	Littelfuse	SMCJ440CA
HV-AC1	FCR7350R	Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Red	Cliff ELectronics Component Linited	FCR7350R
HV-AC2	FCR7350B	Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Black	Cliff ELectronics Component Linited	FCR7350B
R1	2.2R	RES / STD / 2.2R / 250mW / 1% / 100ppm/K / -55°C to 155°C / 1206(3216) / SMD / -	Vishay	CRCW12062R20FK
R2	100R	RES / STD / 100R / 100mW / 1% / 100ppm/K / -55°C to 155°C / 0603(1608) / SMD / -	Vishay	CRCW0603100RFK
R3	100R	RES / STD / 100R / 125mW / 1% / 100ppm/K / -55°C to 155°C / 0805(2012) / SMD / -	Vishay	CRCW0805100RFK
R9	0R	RES / STD / 0R / - / 0% / - / -55°C to 155°C / 1206(3216) / SMD / -	Vishay	CRCW12060000Z0EA
Rsh	22mR	RES / STD / 22mR / 1W / 1% / 35ppm/K / -55°C to 155°C / 1206(3216) / SMD / -	Susumu	KRL3216T4A-M-R022-F-T1
T1, T2	IPT60R065S7	600V CoolMOS SJ S7 PowerDevice	Infineon Technologies	IPT60R065S7
U1	iSSI20R11H	Coreless-Transformer Advanced Solid-State Isolator	Infineon Technologies	iSSI20R11H
X2	N2510-6002RB	Header, 4-Wall Lo-PRO, .100, Straight, 10Pins, 2.54mm Pitch	3M	N2510-6002RB

Revision history

Document revision	Date	Description of changes
1.0	2024.04.10	Initial version

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