

# Eval-iSSI20R02HTS user guide

## Board description

### iSSI20R02H

**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-iSSI20R02HTS features the coreless-transformer advanced solid-state isolator, iSSI20R02H. This user guide covers the design revision 1.0 of this evaluation board.

iSSI20R12H 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 iSSI20R02H
- Experienced design engineers who design circuits with photovoltaic isolators (PVI), IGBTs, and MOSFETs MOSFET
- Design engineers who develop solid-state relays

### Evaluation board

The evaluation board EVAL-iSSI20R02HTS 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.

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*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

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <b>Warning:</b> 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.                                                                                                                                                                                                                  |
|    | <b>Warning:</b> 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.                                                                              |
|    | <b>Caution:</b> 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.                                                                                                                                                                                                                     |
|   | <b>Caution:</b> 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.                                                                                                                                                                                                 |
|  | <b>Caution:</b> 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. |
|  | <b>Caution:</b> 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.                                                                                                                        |
|  | <b>Caution:</b> 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.                                                                                                                                                               |

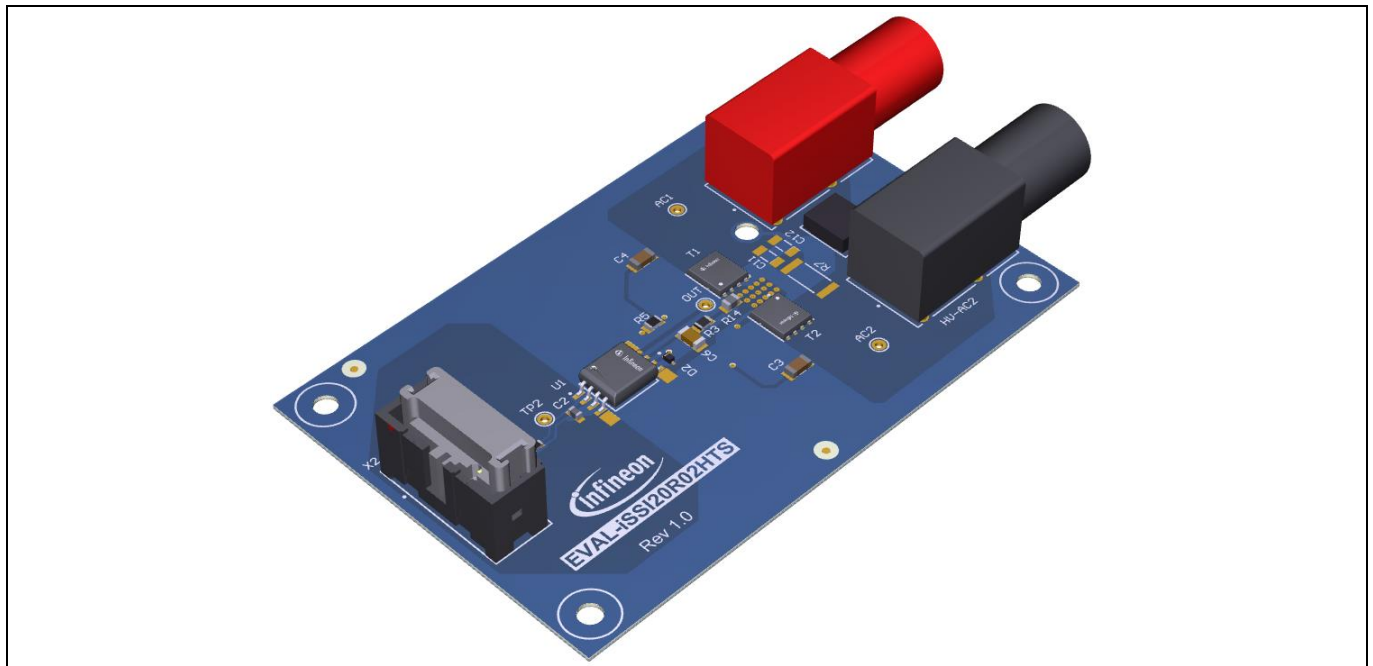
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## 1 Overview and key features

EVAL-iSSI20R02HTS is intended for evaluating the product features of Infineon's SSI solid-state isolator, iSSI20R02H, in an application circuit. The key features of the board and the iSSI20R02H are as follows:

- Evaluation board with iSSI20R02H and two OptiMOS™ ISC035N10NM5LF MOSFETs in an AC switch configuration
- Over-temperature protection with PTC resistor
- Standard turn-on
- Fast turn-off after overcurrent and over-temperature protection
- Dynamic Miller clamping



**Figure 1** The EVAL-iSSI20R02HTS evaluation board

This board is best suited for testing the switching performance of Infineon SSI and OptiMOS™ with a resistive load 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                                                                                                                                                                      |
|----------------------------------------------------|--------------------------------|------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>INP</i>                                         | <i>X2.5, X2.6</i>              | -10  | 3.6 | V    | Input, Infineon SSI solid-state isolator voltage supply                                                                                                                   |
| <i>HV-AC1</i><br><i>HV-AC2</i>                     | <i>HV-AC1</i><br><i>HV-AC2</i> | -100 | 100 | V    | Input, high-voltage power supply. For 42 V and above, special high-voltage lab environment is strongly recommended                                                        |
| <i>RMS current</i>                                 | <i>HV-AC1/2</i>                | -    | 6.5 | A    |                                                                                                                                                                           |
| <i>DC current</i>                                  | <i>HV-AC1/2</i>                | -    | 10  | A    |                                                                                                                                                                           |
| <i>AC1 peak current</i><br><i>AC2 peak current</i> | <i>HV-AC1</i><br><i>HV-AC2</i> | -    | 20  | A    | Phase peak current for overcurrent protection test ( $t_{\text{pulse}} < 20\mu\text{s}$ )                                                                                 |
| <i>Switching frequency</i>                         | $f_{\text{sw}}$                | -    | 1   | Hz   | Maximum switching frequency for continuous operation. Power dissipation required for power transistor and Infineon SSI solid-state isolator has been carefully considered |
| <i>Ambient temperature</i>                         | $T_a$                          | -    | 30  | °C   |                                                                                                                                                                           |

The printed circuit board (PCB) assembly is optimized for a *INP* 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                                                                                                                                             |
|----------------------------|------|------|------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>INP</i>                 | 2.5  | 3.3  | 3.5  | V             | Input voltage supply                                                                                                                             |
| <i>HV-AC1</i>              | -60  | -    | 60   | V             | Input, high-voltage power supply, referenced to <i>HV-AC2</i> . For 42 V and above, special high-voltage lab environment is strongly recommended |
| <i>Inductive load</i>      | -    | -    | 15   | $\mu\text{H}$ |                                                                                                                                                  |
| <i>Ambient temperature</i> | -    | 25   | 30   | °C            |                                                                                                                                                  |

## 3 Getting started with EVAL-iSSI20R02HTS

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,  $INP$ , with a current capability of at least 25 mA for  $INP$ . For repetitive switching operation, a suitable function generator can be used, too.
- Have a power supply,  $V_{HV}$ , in series with a suitable load,  $Z_{Load}$ , ready to connect  $HV-AC1$  and  $HV-AC2$

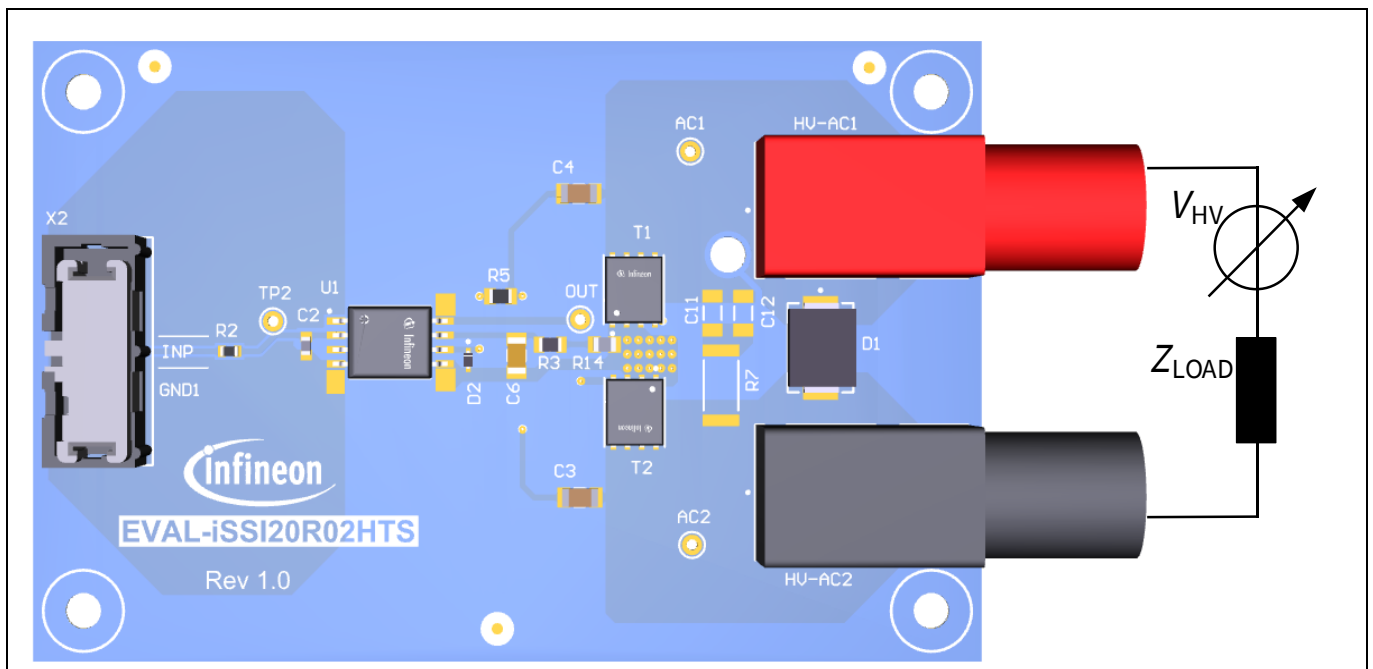
To adapt the circuit to application requirements, resistor or capacitor values can be changed to optimize performance.

### Steps to power up the board

1. Connect the supply voltage,  $INP$ , to connector  $X2.5$  with +3.3 V and the ground,  $GND$ , to connector  $X2.7$ .
2. Connect the power supply,  $V_{HV}$ , to connector  $HV-AC1$ .
3. Connect the ground of power supply,  $V_{HV}$ , to one end of the load,  $Z_{Load}$ , and the other end to connector  $HV-AC2$ .
4. The board is now ready to evaluate switching.

### Steps to safely power down the board

5. Turn off the power supply,  $V_{HV}$ .
6. 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).
7. 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,  $R_{sh}$ . This signal passes a noise RC filter, consisting of  $R3$  and  $C6$ . The integrated comparator of the Infineon SSI compares it to a fixed threshold voltage

$|V_{CS,th}|$  at terminal CS of iSSI20R02H. The maximum peak current can be adapted to application requirements by changing the shunt resistor,  $R_{sh}$ , using the following equation:

$$R_{sh} = \frac{V_{CS,th}}{I_{pk,max}}$$

Once triggered, the protection reacts quickly and is able to turn off, for example, OptiMOS™ ISC035N10NM5LF in a very short time. Thus, it is able to support AC-15 or other 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 0 V to  $INP$  is required.

## 3.2 Over-temperature protection

iSSI20R02H 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 (R6, C7).

Once triggered, the protection reacts quickly and is able to turn off, for example, OptiMOS™ ISC035N10NM5LF 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 0 V to  $INP$  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/<br>function                     | Note                                                                                                                   |
|-----------|-----------------------------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| X2        | 1, 2, 3, 4<br>5, 6<br>7, 8, 9, 10 | <i>VSUP</i><br><i>INP</i><br><i>GND1</i> | Not in use<br>Infineon SSI solid-state isolator input and supply signal<br>Infineon SSI solid-state isolator reference |
| HV-AC1    | 1                                 | <i>HV-AC1</i>                            | High-voltage power supply                                                                                              |
| HV-AC2    | 1                                 | <i>HV-AC2</i>                            | 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)

# 4 Schematic diagram

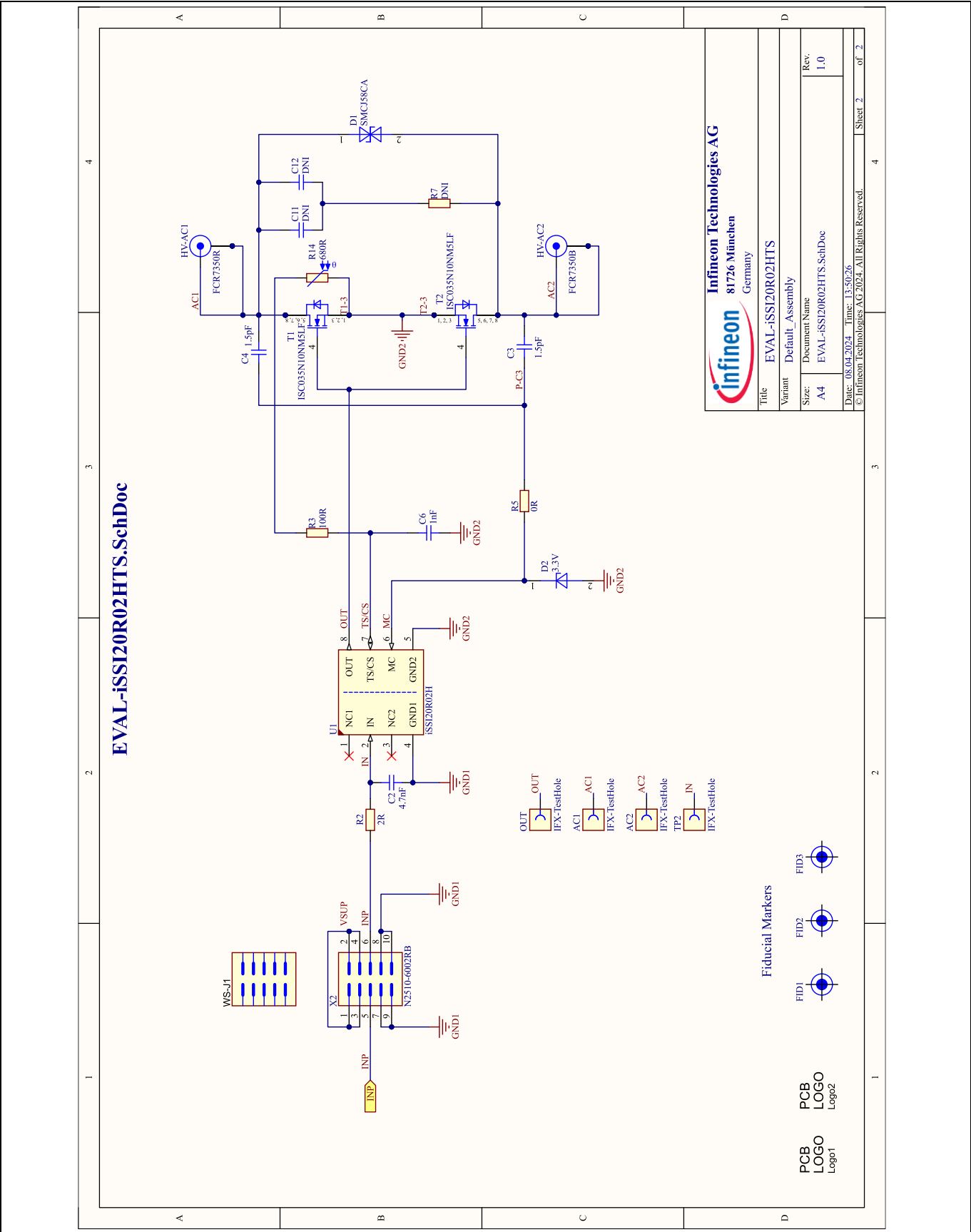


Figure 3 Schematics of EVAL-iSSI20R02HTS (assembled components only)

# 5      Layout

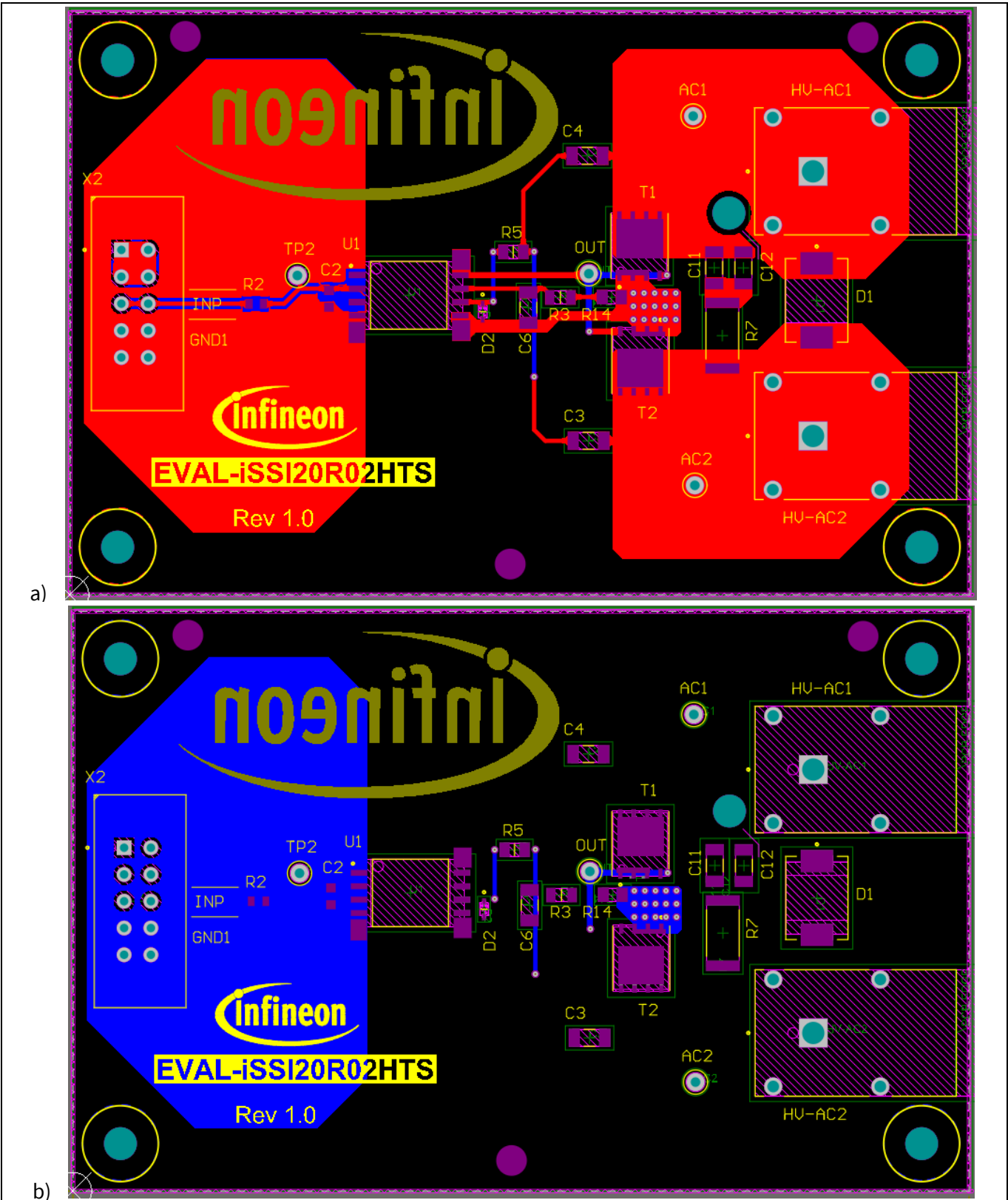


Figure 4      Top (a) and bottom (b) layers of EVAL-iSSI20R02HTS

## 6 Bill of materials

**Table 5 EVAL-iSSI20R02HTS bill of materials**

| Component | Value          | Description                                                                                                  | Manufacturer                        | Part number       |
|-----------|----------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------|-------------------|
| C2        | 4.7nF          | CAP / CERA / 4.7nF / 25V / 1% / C0G (EIA) / NP0 / -55°C to 125°C / 0603(1608) / SMD / -                      | Kemet                               | C0603C472F3GAC    |
| C3, C4    | 1.5pF          | CAP / CERA / 1.5pF / 2kV / 0.1% / C0G (EIA) / NP0 / -55°C to 125°C / 3.20mm L X 1.60mm W X 0.9mm H / SMD / - | Walsin                              | 1206N1R5B202CT    |
| C6        | 1nF            | CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 1206(3216) / SMD / -                             | MuRata                              | GRM319R71H102KA01 |
| D1        | SMCJ58CA       | Surface Mount TVS Diode, 58V, 1uA                                                                            | Littelfuse                          | SMCJ58CA          |
| D2        | 3.3V           | DIODE ZENER 3.3V 500MW SOD523                                                                                | ON Semiconductor                    | SZMM5Z3V3T1G      |
| HV-AC1    | FCR7350R       | Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Red                         | Cliff Electronics Component Limited | FCR7350R          |
| HV-AC2    | FCR7350B       | Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Black                       | Cliff Electronics Component Limited | FCR7350B          |
| R2        | 2R             | RES / STD / 2R / 100mW / 1% / 100ppm/K / -55°C to 155°C / 0603(1608) / SMD / -                               | Vishay                              | CRCW06032R00FK    |
| R3        | 100R           | RES / STD / 100R / 125mW / 1% / 100ppm/K / -55°C to 155°C / 0805(2012) / SMD / -                             | Vishay                              | CRCW0805100RFK    |
| R5        | 0R             | RES / - / 0R / 125mW / - / - / - / 0805(2012) / SMD / -                                                      | Multicomp                           | MCMR08X000 PTL    |
| R14       | 680R           | RES / PTC / 680R / - / 50% / - / - / 0805(2012) / SMD / -                                                    | TDK Corporation                     | B59721A0080A062   |
| T1, T2    | ISC035N10NM5LF | OptiMOS 5 Linear FET with the Features of Very Low On-Resistance                                             | Infineon Technologies               | ISC035N10NM5LF    |
| U1        | iSSI20R02H     | Coreless-Transformer Advanced Solid-State Isolator                                                           | Infineon Technologies               | iSSI20R02H        |
| X2        | N2510-6002RB   | Header, 4-Wall Lo-PRO, .100, Straight, 10Pins, 2.54mm Pitch                                                  | 3M                                  | N2510-6002RB      |

**Eval-iSSI20R02HTS user guide**

**Board description**

**Revision history**

**Revision history**

| Document revision | Date       | Description of changes    |
|-------------------|------------|---------------------------|
| 1.0               | 2024-04-10 | Initial version           |
| 1.1               | 2024-08-01 | p.5: Key features updated |
|                   |            |                           |

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**Document reference**

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