

# Eval-iSSI30R12H user guide

## Board description

### iSSI30R12H

**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-iSSI30R12H features the coreless-transformer advanced solid-state isolator, iSSI30R12H. This user guide covers the design revision 1.2 of this evaluation board.

iSSI30R12H 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 solid-state isolator iSSI30R12H
- 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-iSSI30R12H 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

	<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.

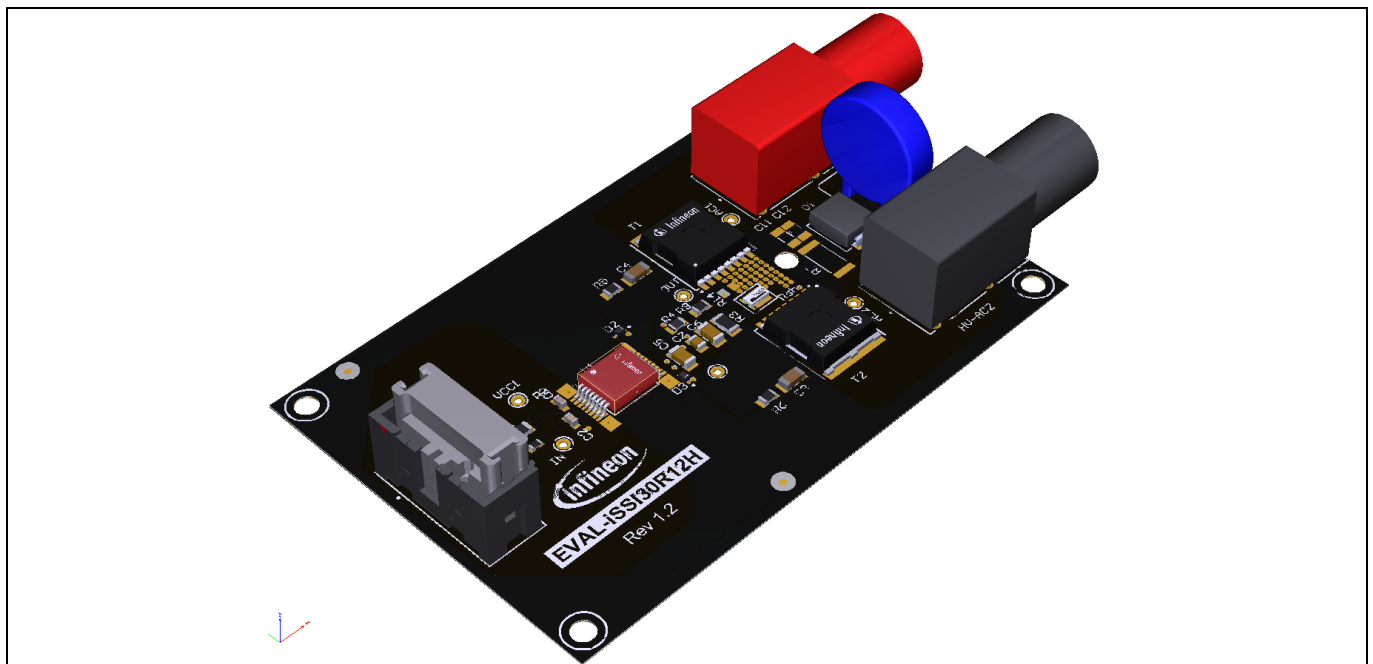
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## 1 Overview and key features

EVAL-iSSI30R12H is intended for evaluating the product features of Infineon's SSI solid-state isolator, iSSI30R12H, in an application circuit. The key features of the board and the iSSI30R12H are as follows:

- Evaluation board with iSSI30R12H and two CoolMOS™ IPT60T022S7 MOSFETs in an AC switch configuration
- Ultra-fast overcurrent detection that is triggered at the typical peak current of 35 A
- Direct-chip temperature measurement of CoolMOS™ with shutdown at 155°C
- Fast turn-on
- Fast turn-off after overcurrent and over-temperature protection
- Dynamic Miller clamping



**Figure 1** The EVAL-iSSI30R12H board

This board is best suited for testing switching, 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/parameter name	Connector	Min	Max	Unit	Note
<i>VSUP</i>	X2.1, X2.2	-10	3.6	V	Input, Infineon SSI solid-state isolator voltage supply
<i>INP</i>	X2.5, X2.6	-10	15	V	Input, digital signal
<i>HV-AC1</i> <i>HV-AC2</i>	<i>HV-AC1</i> <i>HV-AC2</i>	-320	320	V	Input, high-voltage power supply. For 42 V and above, special high-voltage lab environment is strongly recommended
<i>AC-15 RMS current</i>	<i>HV-AC1/2</i>	-	2	A	
<i>RMS current</i>	<i>HV-AC1/2</i>	-	7	A	
<i>DC current</i>	<i>HV-AC1/2</i>	-	7	A	
<i>AC1 peak current</i> <i>AC2 peak current</i>	<i>HV-AC1</i> <i>HV-AC2</i>	-	45	A	Phase peak current for overcurrent protection test ( $t_{\text{pulse}} < 20\mu\text{s}$ )
$f_{\text{sw}}$		-	1	Hz	Maximum switching frequency for continuous operation. Power dissipation required for power transistor and Infineon SSI solid-state isolator has been carefully considered

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	Min.	Typ.	Max.	Unit	Note
<i>VSUP</i>	2.5	3.3	3.5	V	Input voltage supply
<i>INP</i>	0	-	3.3	V	Input, digital signal
<i>HV-AC1</i>	-320	-	320	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

## 3 Getting started with EVAL-iSSI30R12H

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,  $V_{SUP}$ , with a current capability of at least 25 mA for  $V_{SUP}$
- 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,  $INP$

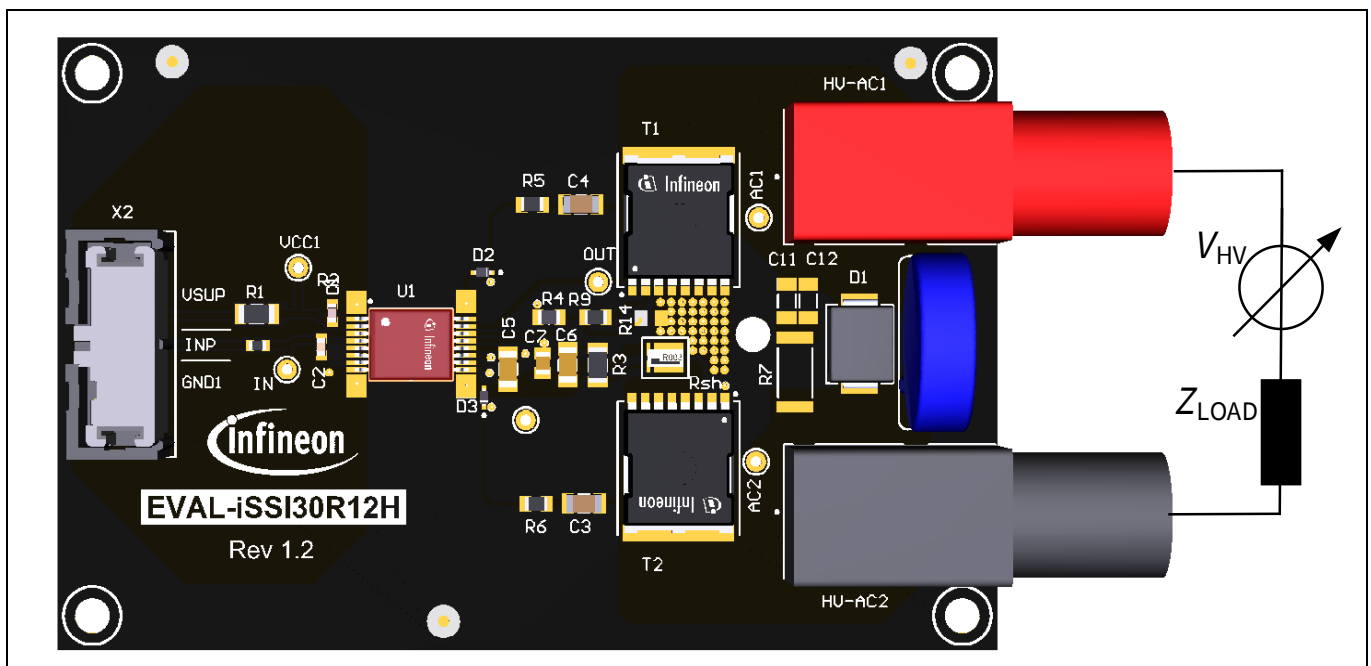
To adapt the circuit to application requirements, resistor or capacitor values can be changed to optimize performance.

### Steps to power up the board

1. Connect the supply voltage,  $V_{SUP}$ , 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

1. Turn off the power supply,  $V_{HV}$ .
2. 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).
3. 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 iSSI30R12H. 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, CoolMOS™ IPT60T022S7 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

iSSI30R12H provides a constant bias current,  $I_{TS,bias}$ , for temperature sense diodes inside CoolMOS™ IPT60T022S7. The constant current generates a temperature-dependent forward voltage at the diodes. The diode voltage is connected to the 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™ IPT60T022S7 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.

## 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 voltage supply reference
HV-AC1	1	$HV-AC1$	High-voltage power supply
HV-AC2	1	$HV-AC2$	



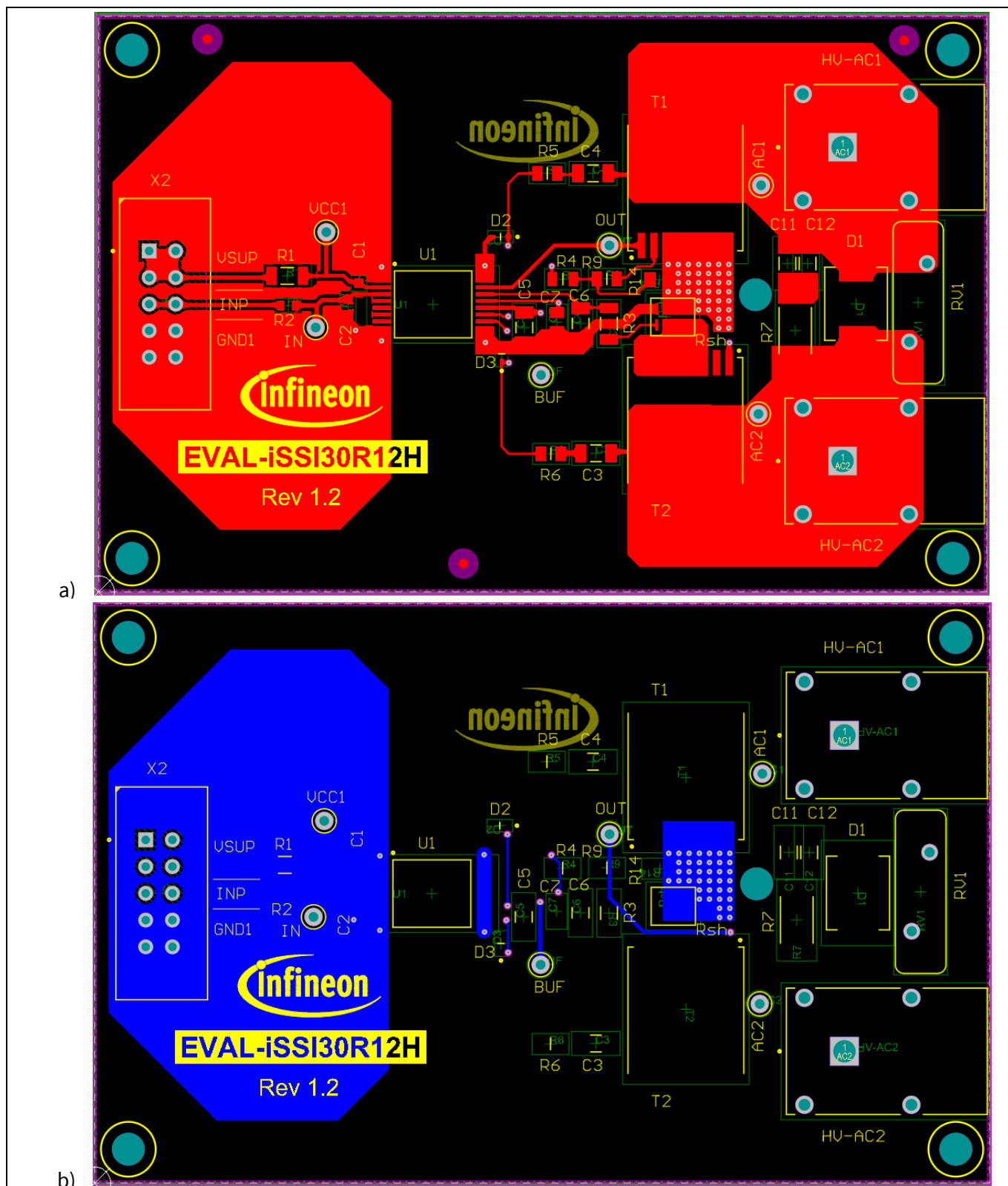
## 3.4 Board options

The evaluation board offer a few functional options implemented by parts that are not populated. These options are:

- Realization of a snubber circuit (C11, C12, R7)
- Using a PTC resistor R14 instead of the on-chip temperature sense of IPT60T022S7. This option requires the following actions:
  - depopulate R9,
  - populate a suitable PTC resistor at footprint R14 and
  - exchange iSSI30R12H by part number iSSI30R11H.



## 5 Layout



**Figure 4** Top (a) and bottom (b) layers of Eval-iSSI30R12H

## 6 Bill of materials

**Table 5 Eval-iSSI30R12H bill of materials**

Component	Quantity	Description	Manufacturer	Part number
C1	1	CAP / CERA / 4.7nF / 25V / 10% / X7R (EIA) / -55°C to 125°C / 0603(1608) / SMD / -	MuRata	GRM188R71E472KA01
C2	1	CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 0603(1608) / SMD / -	Würth Elektronik	885012206083'
C3, C4	2	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
C5	1	CAP / CERA / 68nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 1206(3216) / SMD / -	MuRata	GRM319R71H683KA01
C6	1	CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 1206(3216) / SMD / -	MuRata	GRM319R71H102KA01
C7	1	CAP / CERA / 1nF / 50V / 10% / X7R (EIA) / -55°C to 125°C / 0805(2012) / SMD / -	MuRata	GCM216R71H102KA37
D1	1	TVS Diodes	Littelfuse	SMCJ400CA
D2, D3	2	DIODE ZENER 3.3V 500MW SOD523	ON Semiconductor	SZMM5Z3V3T1G
HV-AC1	1	Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Red	Cliff Electronics Component Limited	FCR7350R
HV-AC2	1	Banana Test Connector, 4mm, Socket, PCB Mount, 24 A, 1 kV, Gold Plated Contacts, Black	Cliff Electronics Component Limited	FCR7350B
R1	1	RES / STD / 2.2R / 250mW / 1% / 100ppm/K / -55°C to 155°C / 1206(3216) / SMD / -	Vishay	CRCW12062R20FK
R2	1	RES / STD / 100R / 100mW / 1% / 100ppm/K / -55°C to 155°C / 0603(1608) / SMD / -	Vishay	CRCW0603100RFK
R3	1	RES / STD / 100R / 250mW / 1% / 100ppm/K / -55°C to 155°C / 1206(3216) / SMD / -	Vishay	CRCW1206100RFK
R4	1	RES / STD / 100R / 125mW / 1% / 100ppm/K / -55°C to 155°C / 0805(2012) / SMD / -	Vishay	CRCW0805100RFK

Component	Quantity	Description	Manufacturer	Part number
R5, R6, R9	3	RES / - / 0R / 125mW / - / - / - / 0805(2012) / SMD / -	Multicomp	MCMR08X000 PTL
Rsh	1	RES / STD / 6mR / 1W / 1% / 75ppm/K / -55°C to 155°C / 1206(3216) / SMD / -	Susumu	KRL3216T4A-M-R006-F-T1
RV1	1	RES / STD / - / - / - / - / -40°C to 105°C / 7.50mm C X 0.80mm W 15.50mm L X 4.80mm T X 18.50mm H / THT / -	TDK Corporation	B72214S0251K101
T1, T2	2	MOSFET 600V, 22 mΩ CoolMOS™ S7 Power Device with temperature sensor	Infineon Technologies	IPT60T022S7
U1	1	Coreless-Transformer Advanced Solid-State Isolators	Infineon Technologies	iSSI30R12H
WS-J1	1	Wiremount Socket, 100mil, 5x2, Gray	3M	3473-6600
X2	1	Header, 4-Wall Lo-PRO, .100, Straight, 10Pins, 2.54mm Pitch	3M	N2510-6002RB

**Revision history**

Document revision	Date	Description of changes
1.0	2023.12.19	Initial version
1.20	2024.02.12	Updated to revision 1.20 (footer)
1.30	2024.08.01	Updating UL 1577 certification status
1.30	2024.08.01	Replacing term “iSSI” with “Infineon SSI”

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