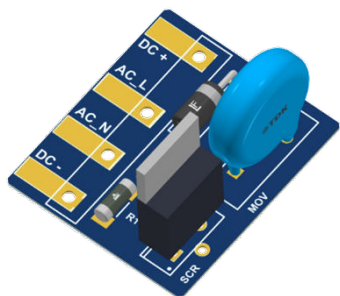


Overvoltage protection reference design



Product summary

STDES-OVP001

Product summary

SCR1	TN1605H-8T
SCR2	TN5015H-8T
TVS1	P6KE440A
TVS2	P6KE300A/ P6KE350A

Features

- Up to 6 kV surge protection in differential mode between line and neutral
- Compliant with IEC61000-4-5
- 3 different configurations to fit application requirements of:
 - Surge level: up to 6 kV
 - Line voltage : up to 400 V AC
 - DC/DC MOSFET $V_{(BR)DSS}$ ratings
- High Temperature Thyristors SCRs with I_{PP} 8/20 μ s during surge:
 - TN1605H-8T up to 1100 A
 - TN5015H-8T up to 1800 A
- Very low leakage current: max. 210 nA according to board configuration at AC input voltage 400 V
- SCRs Thyristors are halogen-free and lead-free plating
 - [ECOPACK2](#) power package

Applications

- Server and telecom SMPS
- Consumer SMPS
- EV chargers
- UPS

Description

The STDES-OVP001 is a plug-and-play demonstration kit to perform IEC61000-4-5 test in SMPS, EV charger or UPS.

The SCR-based solution proposed is able to reach high level of surge voltage up to 6 kV, to protect the DC/DC of the system without any failure, especially to protect high voltage 650 V or 800 V of V_{DSS} MOSFET.

The kit is split into four different configurations, to reach high performance of protection according to the application requirements.

SCR Thyristors TN1605H-8T and TN5015H-8T are two high temperature 800V devices used in the versions of board STDES-OVP001, in the TO-220-AB package. It is environmentally friendly [ECOPACK2](#), RoHS (2011/65/EU) and Halogen Free compliant.

The TO-220-AB package is also UL-94, V0 flammability resin compliance and RoHS (2011/65/EU) compliant

1 Getting started

Figure 1. Pictograms



Danger: Use the *STDES-OVP001* board only after applying a fire-resistant cover. The cover is not included in the board package.

There is a danger of serious personal injury, property damage, or death due to electrical shock and burn hazards if the kit or components are improperly used or installed incorrectly.

Warning: The kit is not electrically isolated from the high-voltage supply AC-DC input. The evaluation board is directly linked to the mains voltage. No insulation is ensured between the accessible parts and the high voltage. All measurement equipment must be isolated from the mains before powering the board.

When using an oscilloscope with the evaluation board, it must be isolated from the AC line. This prevents shock from occurring as a result of touching any single point in the circuit, but does not prevent shock when touching two or more points in the circuit.

Caution: During assembly, testing, and operation, the evaluation board poses several inherent hazards, including bare wires, moving or rotating parts and hot surfaces. All operations involving transportation, installation, use, and maintenance must be performed by skilled technical personnel who are familiar with the installation, use, and maintenance of power electronic systems.

The board has to be connected directly on the mains. Non-isolated parts at high-voltage levels are present on both sides of the PCB.

The high current flowing through the SCR generate heat: the board temperature can reach up to 150 °C at full power. Be aware that, due to the thermal inertia, the board could remain hot even after the current flow.

Workarea safety:

- The work area must be clean and tidy
- Do not work alone when boards are powered
- Protect the area against any unauthorized access by putting suitable barriers and signs
- A system architecture that supplies power to the evaluation board must be equipped with additional control and protective devices in accordance with the applicable safety requirements (that is, compliance with technical equipment and accident prevention rules).

Electrical safety:

- Remove the power supply from the evaluation board and electrical loads before performing any electrical measurement
- Arrange measurement setup, wiring, and configuration, paying attention to the high voltage section
- Once the setup is complete, power the board. Fuse protection is not included with this evaluation board.

Danger: Do not touch the evaluation board when it is powered or immediately after it has been disconnected from the voltage supply as several parts and power terminals containing potentially energized capacitors need time to discharge, and heat-sink and transformers may still be very hot.

Personal safety:

- Always wear suitable personal protective equipment, such as insulating gloves and safety glasses
- Take adequate precautions and install the board to prevent accidental touch
- Use protective shields, such as an insulating box with interlocks.

2 BOM

Table 1. STDES-OVP001 Bill of materials

Product	V1	V2	V3	V4
SCR	TN1605H-8T	TN5015H-8T	TN5015H-8T	TN5015H-8T
TVS	P6KE440A	P6KE440A	P6KE440A	P6KE350A / P6KE300A
MOV	S14K250	S14K150	S14K130	S14K175
R _G	10 Ω	10 Ω	10 Ω	10 Ω
R1	10 kΩ	10 kΩ	10 kΩ	10 kΩ
Rectifier bridge	(Optional: in case the board is plugged in AC line side)			

3 Schematics

Figure 2. Schematics of STDES-OVP001

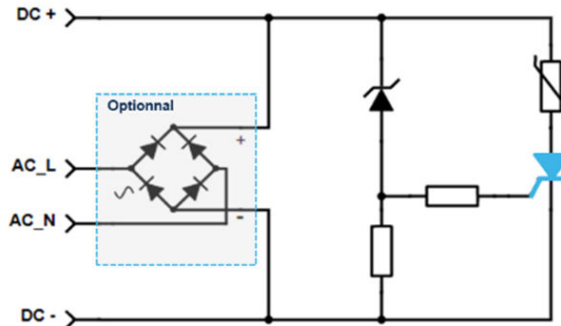


Figure 3. Implementation of the STDES-OVP001 on an SMPS before rectification

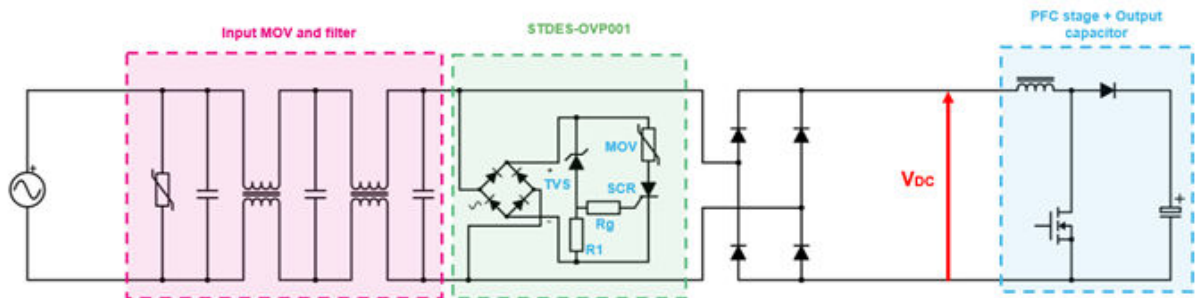


Figure 4. Implementation of the STDES-OVP001 on an SMPS after rectification

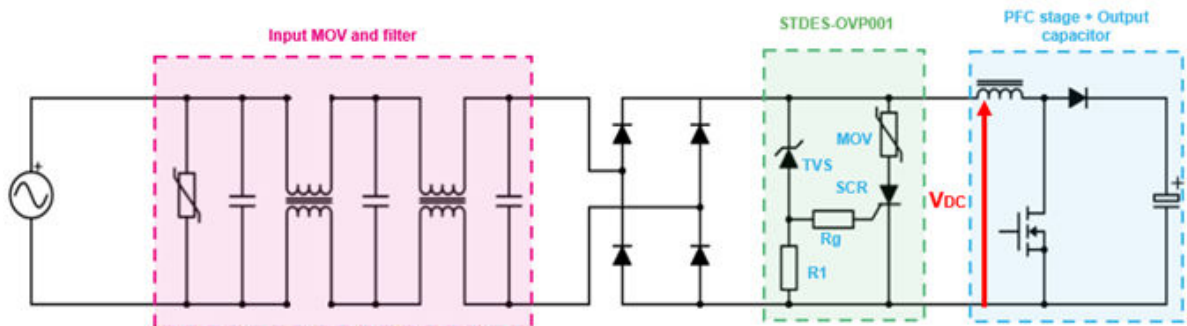


Table 2. STDES-OVP001 versions

Versions	STDES-OVP001V1	STDES-OVP001V2	STDES-OVP001V3	STDES-OVP001V4
Grid voltage	230 V	230 V	230 V	400 V
Surge IEC61000-4-5	±4 kV	±6 kV	±4 kV	±6 kV
Capacitor values	> 250 µF	> 250 µF	50 µF	> 300 µF

4 Performances

Figure 5. Surge level versus MOSFET voltage for 230 VAC

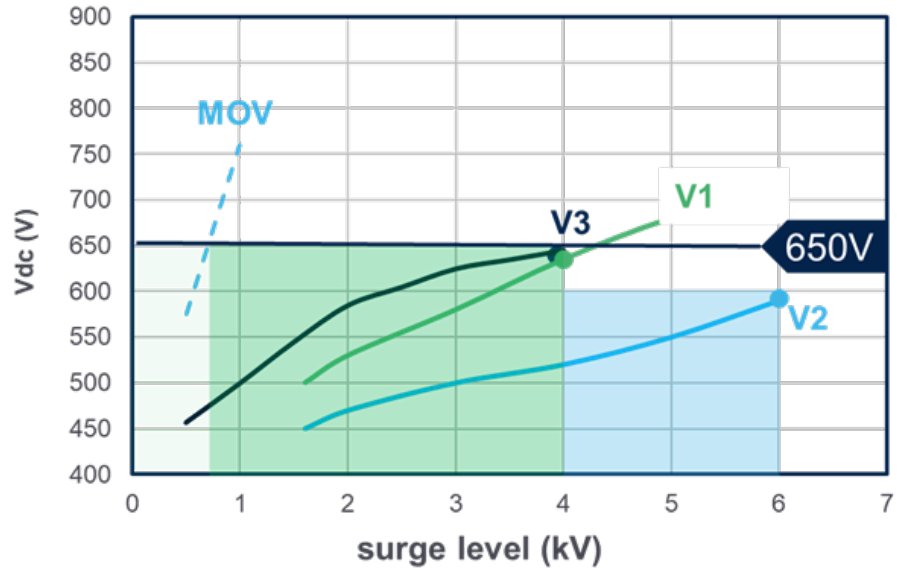


Figure 6. Surge level versus MOSFET voltage for 400 VAC

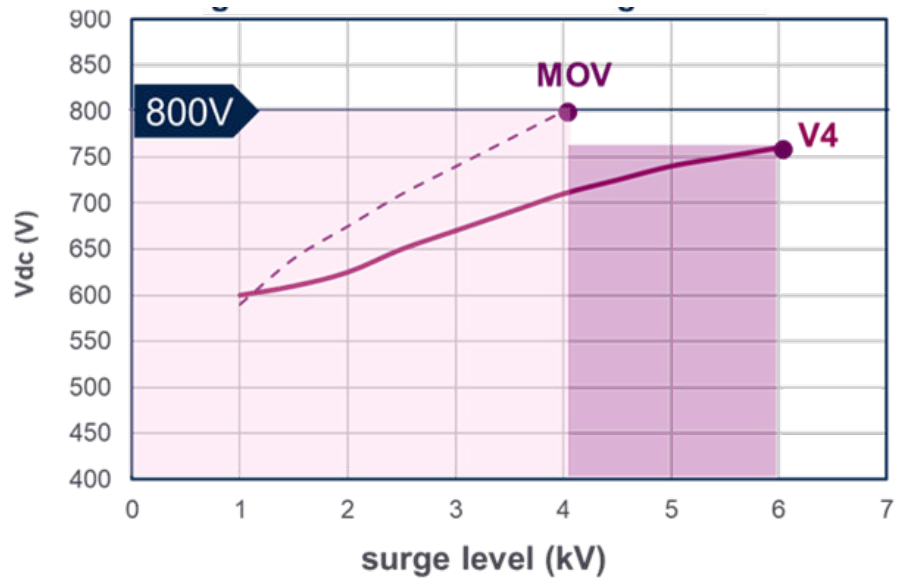


Table 3. Test conditions

Versions	STDES-OVP001V1	STDES-OVP001V2	STDES-OVP001V3	STDES-OVP001V4
Input MOV	S14K385	S14K385	S14K130	S14K175
C_{out} (μF)	270	270	50	300
MOSFET (V_{DSS} in V)	650	650	650	800

5 Layout

Figure 7. STDES-OVP001V1 layout

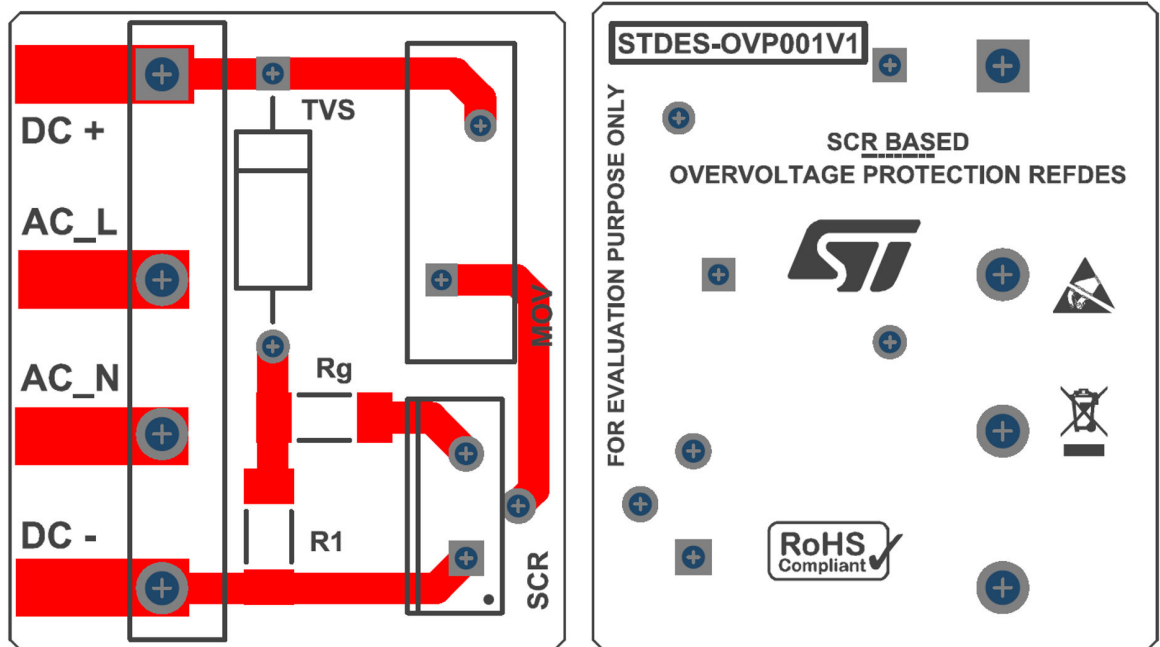
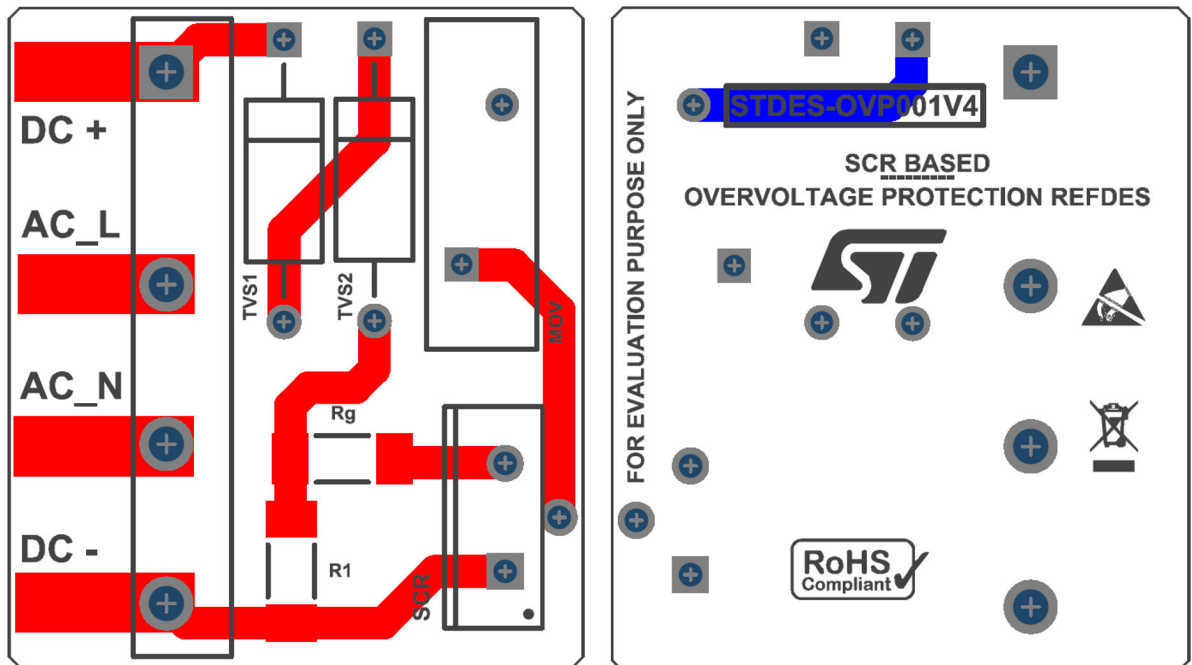


Figure 8. STDES-OVP001V4 layout



6 PCB stack-up

Figure 9. Layers stack-up

Board Stack Report					
Stack Up		Layer Stack			
Layer	Board Layer Stack	Name	Material	Thickness	Constant
1		Top Paste			
2		Top Overlay			
3		Top Solder	Solder Resist	0.010mm	3.5
4		Top Layer	Copper	0.070mm	
5		Dielectric 1	FR-4	1.400mm	4.8
6		Bottom Layer	Copper	0.070mm	
7		Bottom Solder	Solder Resist	0.010mm	3.5
8		Bottom Overlay			
9		Bottom Paste			
Height : 1.560mm					

7 Standard View

Figure 10. STDES-OVP001V1 standard view

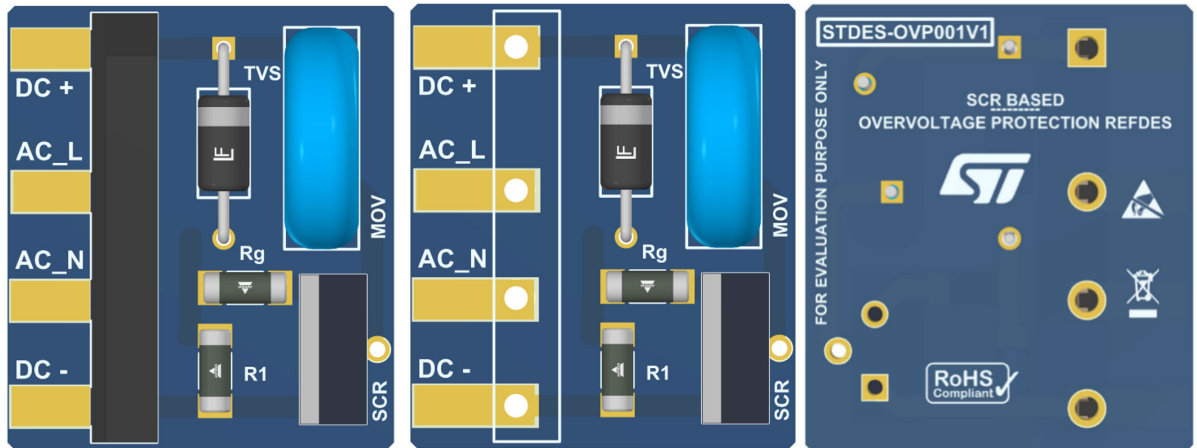
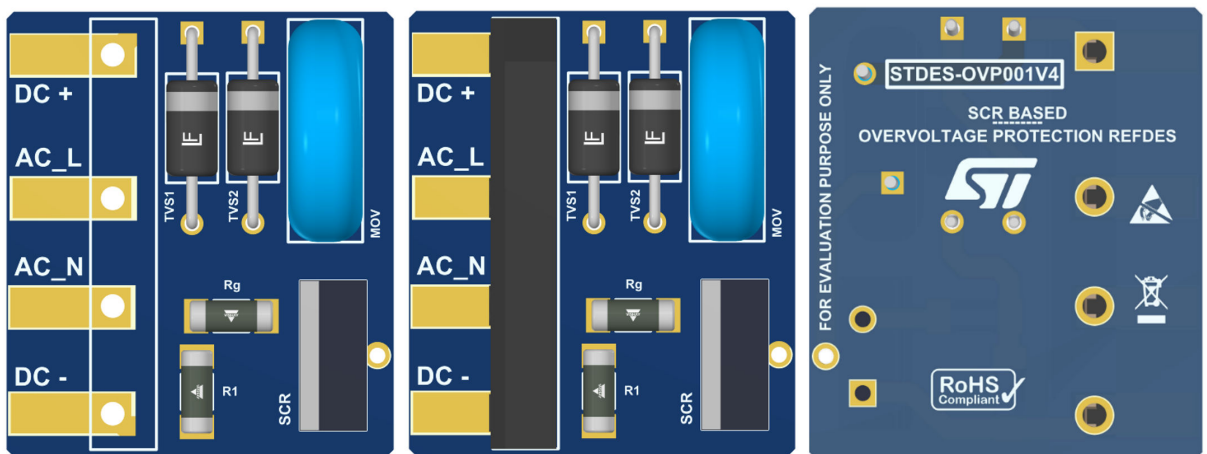
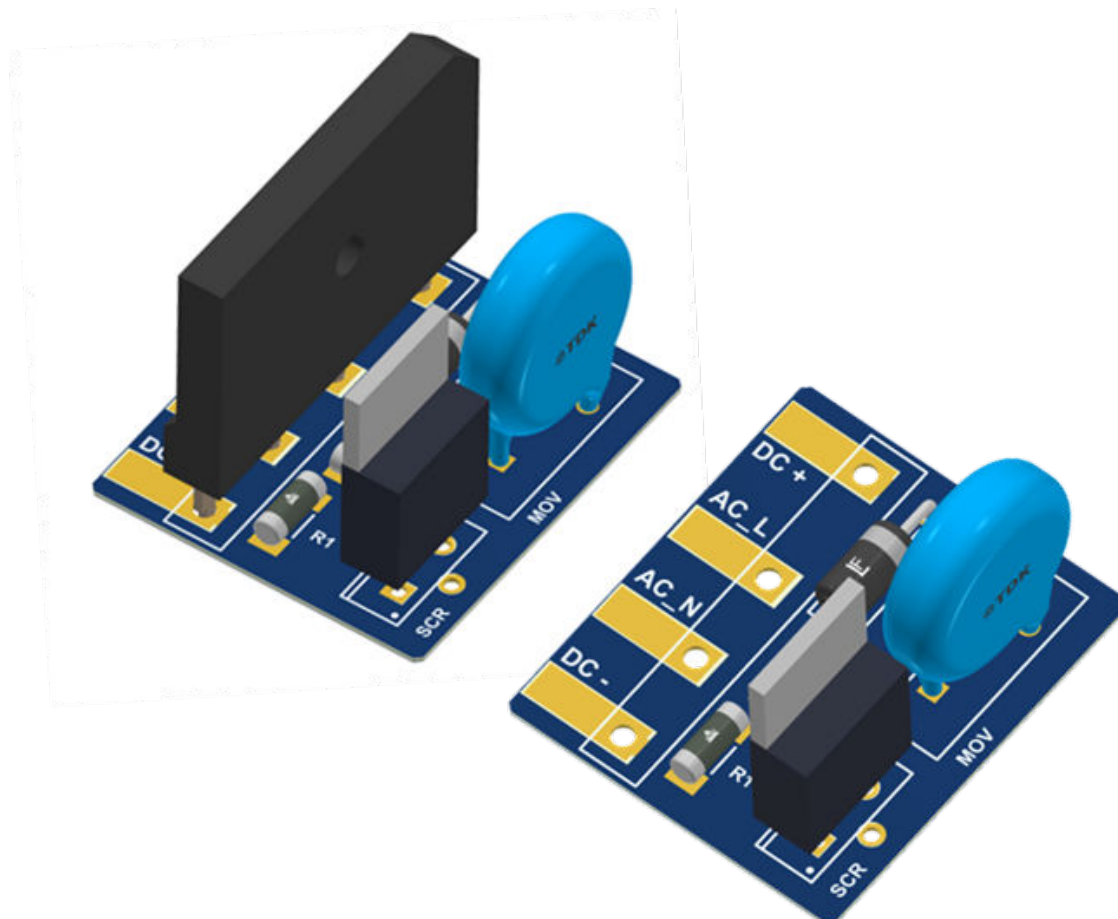


Figure 11. STDES-OVP001V4 standard view



8 3D views

Figure 12. STDES-OVP001 3D view



Revision history

Table 4. Document revision history

Date	Revision	Changes
04-Oct-2023	1	Initial release.
26-Jul-2024	2	Added Getting started.

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