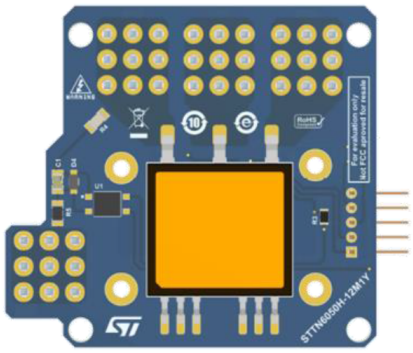
STDES-SSR002V1

Data brief

60 A 1200 V solid state relay



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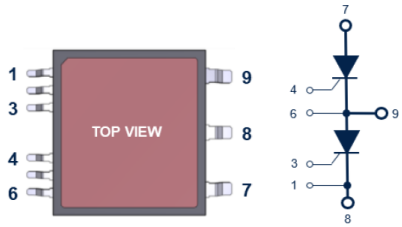


STTN6050H-12M1Y

Product summary
STDES-SSR002V1

Key product
STTN6050H-12M1Y

Features

- 60 A 1200 V Thyristor module STTN6050H-12M1Y
- Package with top side cooling and optimized thermal management
- Insulated gate driver included
- Ready to test controlled half bridge module
- Direct connection to STM32 interface

Applications

- Single and tri-phase controller rectifier bridge
- OBC and charging stations
- Solid state relay in heating control and motor starter
- AC/DC converter for motor drive, UPS and SMPS
- Energy storage

Description

The STDES-SSR002V1 is a ready to use reference design that features SCR module STTN6050H-12M1Y. The reference design allows the evaluation of the module as a 60 A switch for automotive and industrial AC applications.

The reference design includes a driving circuit featuring a pulse transformer.

The key product STTN6050H-12M1Y is an automotive qualified 60 A 1200 V thyristor controlled half-bridge module assembled in the top side-cooled package ACEPACK SMIT.

It offers higher specified noise immunity of 1000 V/µs and overvoltage robustness V_{DSM} up to 1400 V. It also has optimized thermal management.

1 Getting started

Figure 1. Pictograms

Danger: *Use the STDES-SSR002V1 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 no 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 SCRs generates 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.

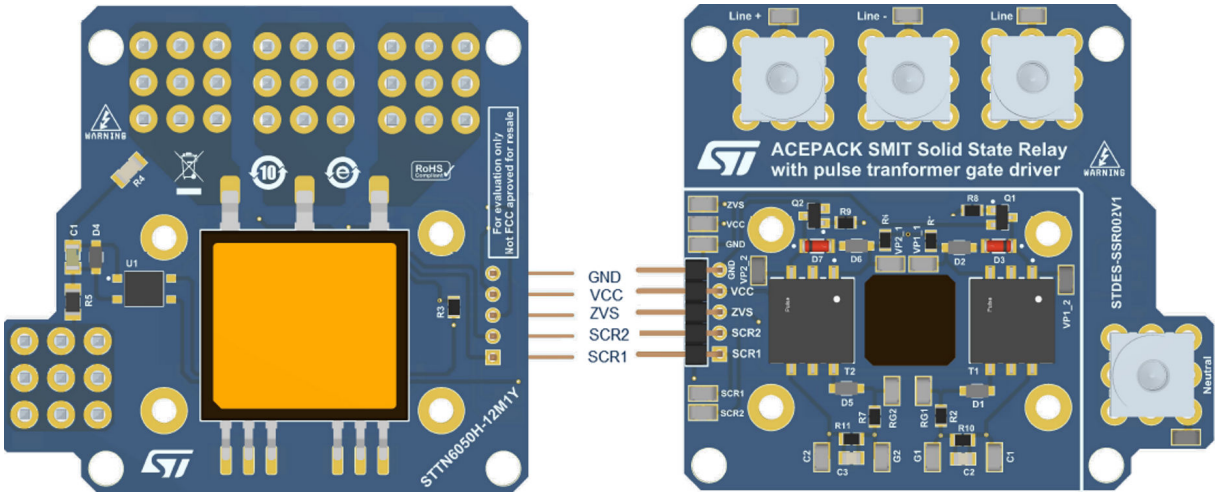
Danger: *Do not touch the evaluation board when it is powered or immediately after it has been disconnected from the voltage supply as several parts and power terminals containing potentially energized capacitors need time to discharge, and heat-sink and transformers may still be very hot.*

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.

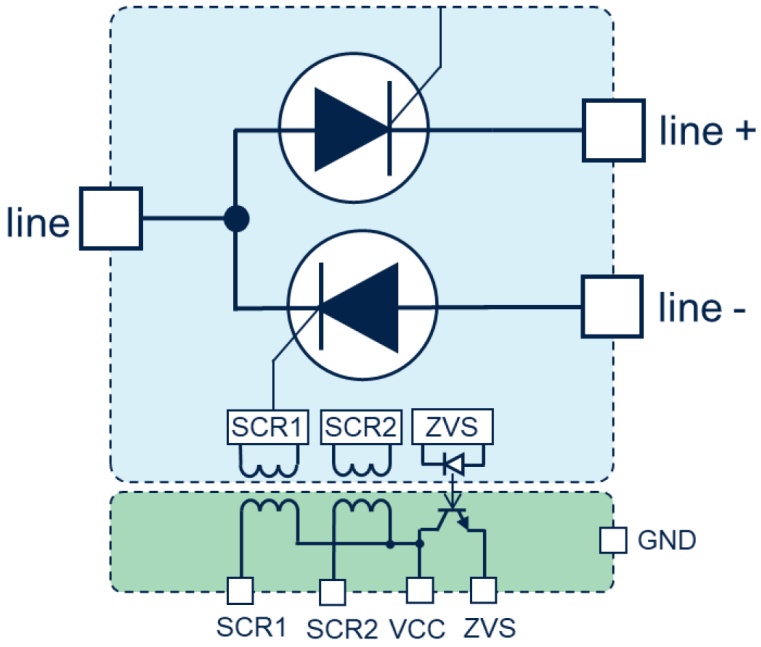
2 Pinout and recommendation

Figure 2. **STDES-SSR002V1 2D view**



The connectors line, line+, line– and neutral should be connected as needed in the AC application.

Figure 3. **STDES-SSR002V1 pinout**

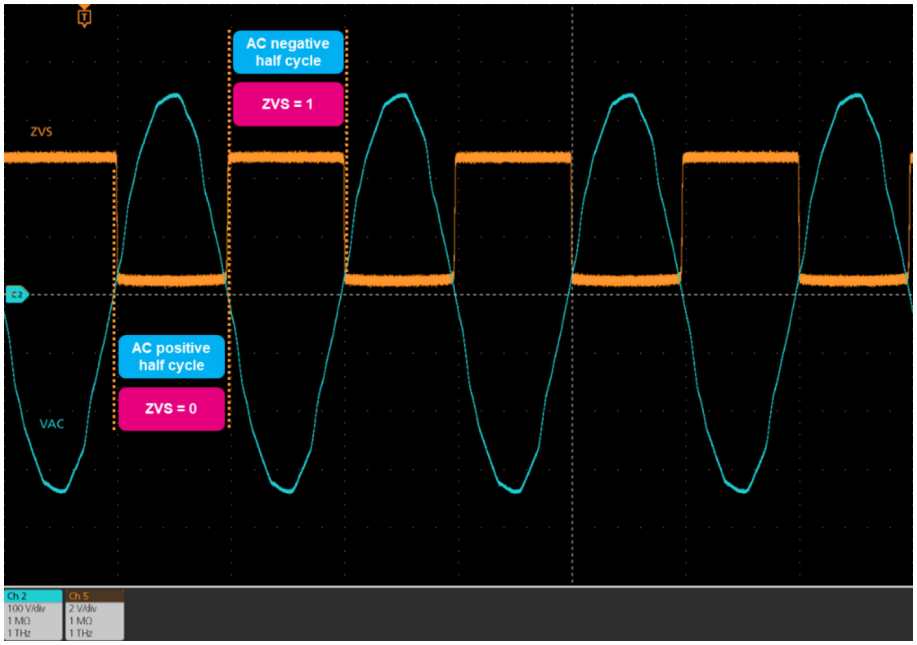


To test the reference design, two signals are to be provided from the microcontroller to drive the two Thyristors of the module SCR1 and SCR2. GND and V_{CC} are to be connected as well. ZVS is an output of the board and could be visualized if needed. ZVS signal provides the AC voltage polarity information to the MCU in order to synchronize the SCR driving signal on SCR1 and SCR2 pins.

Figure 4 features a visual of the ZVS signal. The AC voltage is represented in light blue and the ZVS output signal is shown in orange:

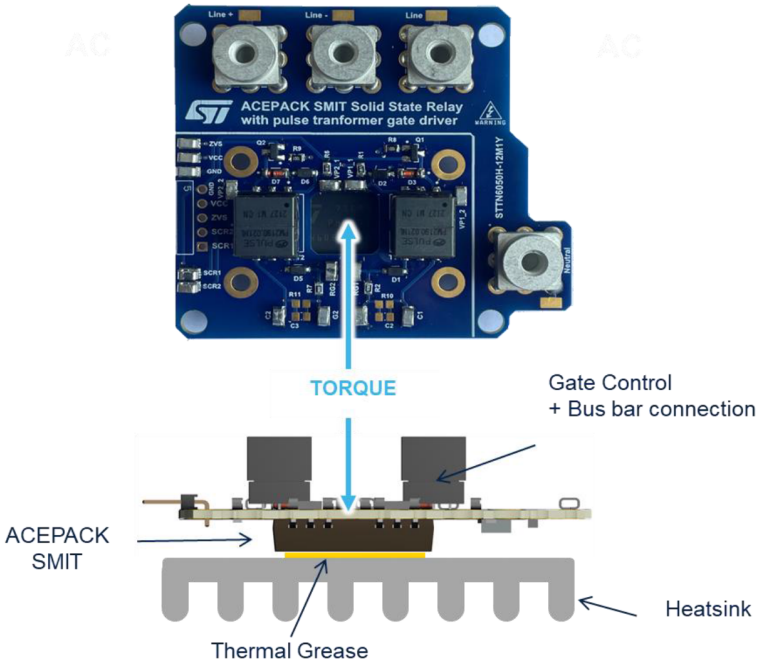
- ZVS level is low during AC positive half cycle
- ZVS level is high during AC negative half cycle.

Figure 4. **ZVS output signal on STDES-SSR002V1**



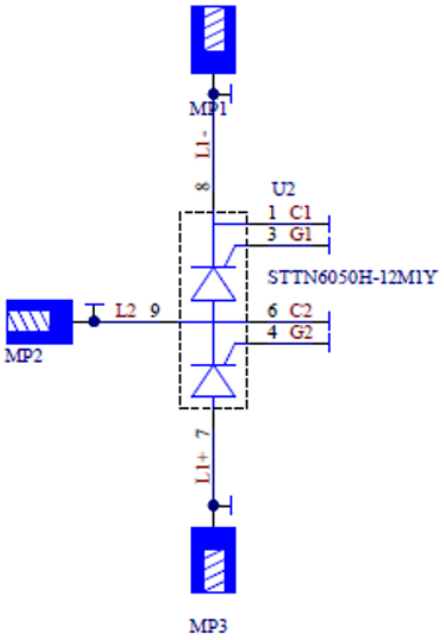
The reference design PCB features an opening underneath the module STTN6050H-12M1Y that we recommend. To attach the module to a heatsink, torque is applied (refer to AN5384 : ACEPACK SMIT module package guidelines for mounting and thermal management). Having the opening allows the torque to be applied directly on the module and thus protecting the PCB and contact with component pins from mechanical risks that might result from the force applied.

Figure 5. **STDES-SSR002V1 view on the PCB opening**



3 Schematics

Figure 6. **Power connectors of the board and STTN6050H-12M1Y**



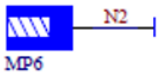


Figure 7. **External connectors of STDES-SSR002V1**

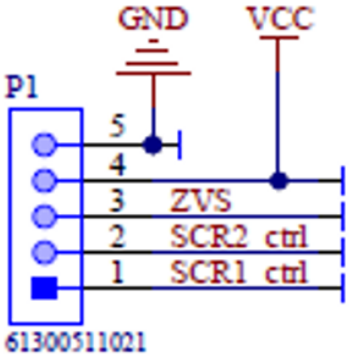


Figure 8. **ZVS detection circuit of STDES-SSR002V1**

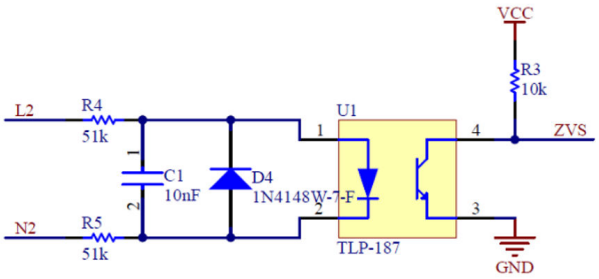
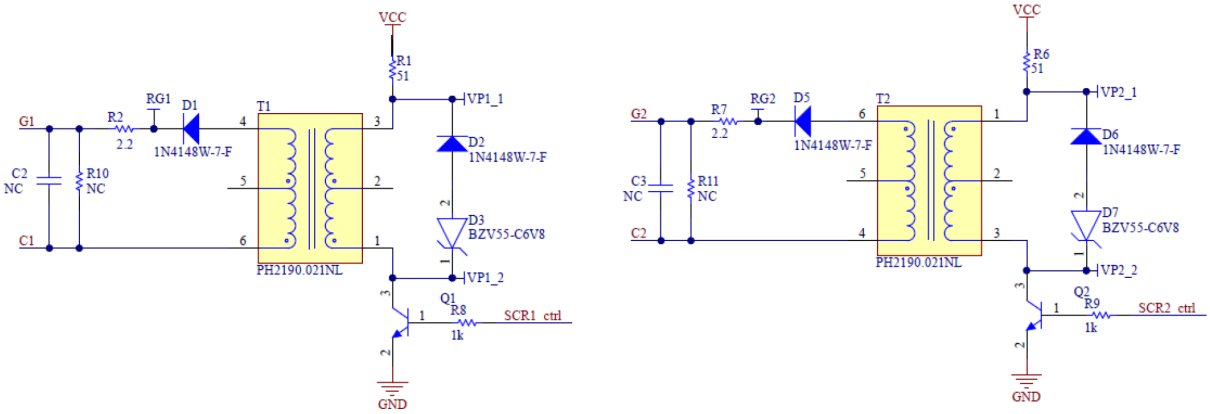
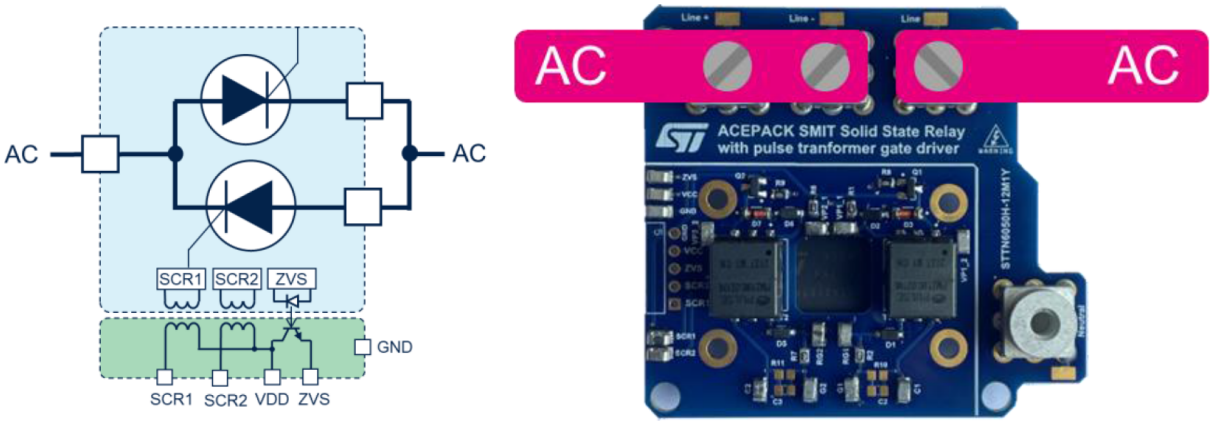


Figure 9. **SCR pulse transformer gate drivers**



4 Use case: 60 A AC switch

Figure 10. Pinout of 60 A AC switch using STDES-SSR002V1

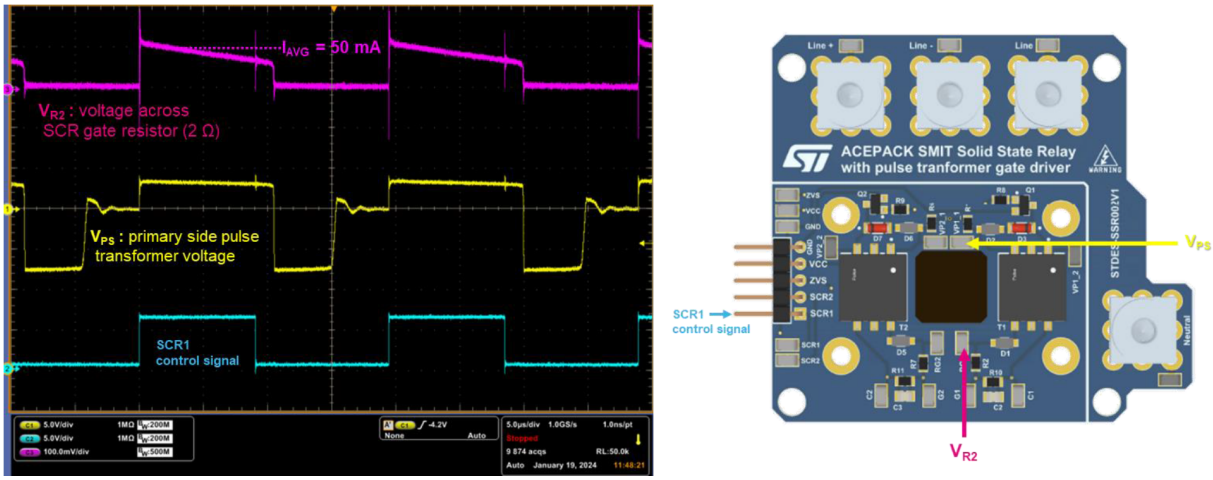


By shortcutting the two AC connectors as shown in Figure 10, we obtain a 60 A AC switch, ready to use for different types of applications.

Figure 11 shows signals on the oscilloscope in an example of driving the 60 A AC switch. Through the microcontroller we provide a driving signal at 50 kHz, with a 50% duty cycle for both SCR1 and SCR2. The driving signal is in light blue. Other voltages are measured and viewed.

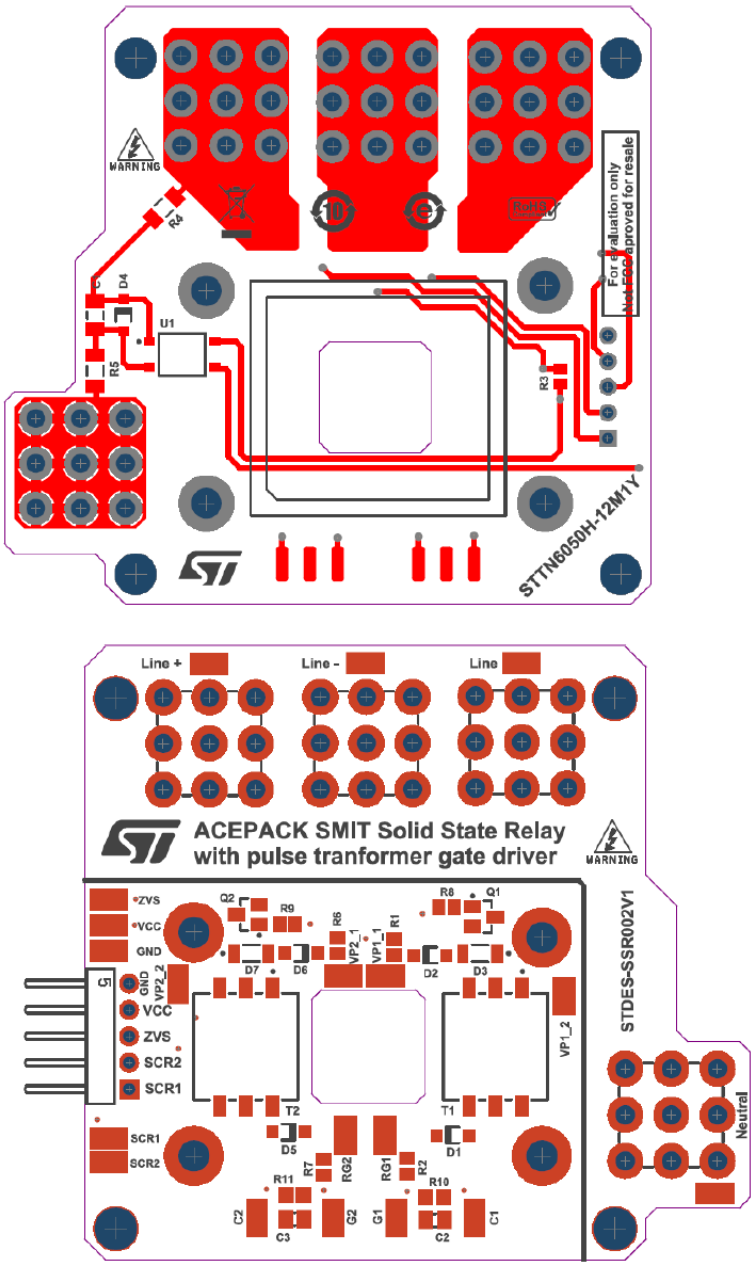
Yellow signal is the voltage at the primary winding of the pulse transformer used for driving in this reference design. The pink color shows the voltage around resistor R2 (featured on 2 Schematics). We can see that 50 mA is the current sent through the gate of each SCR.

Figure 11. Example of driving signal of the 60 A AC switch



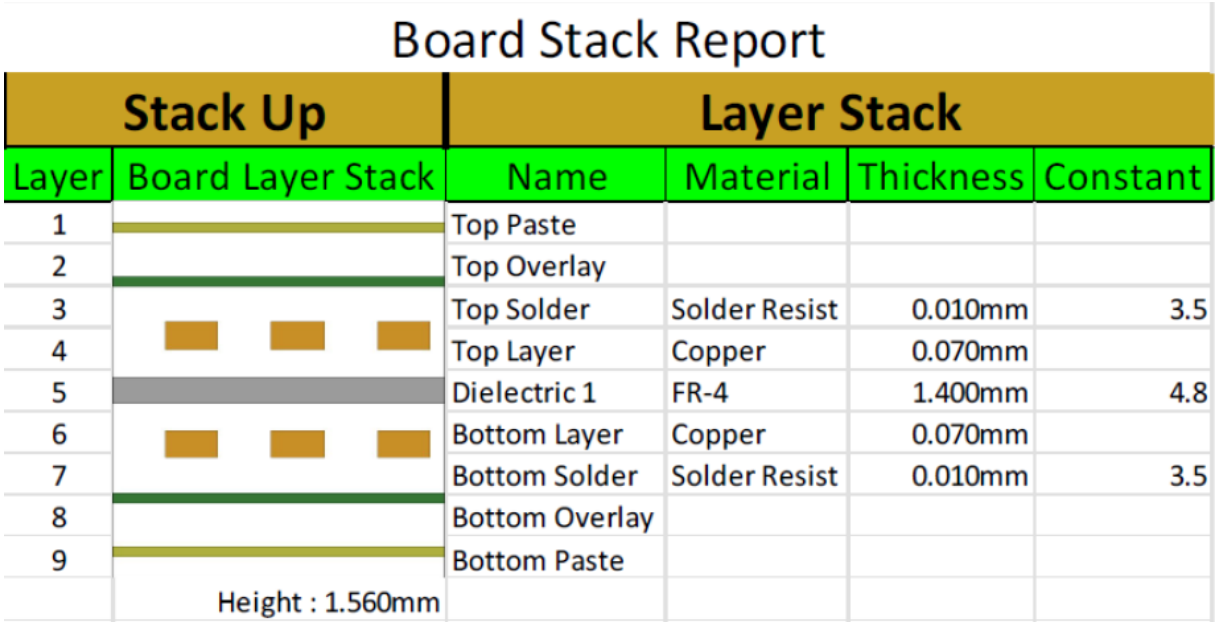
5 Layout

Figure 12. **STDES-SSR002V1 layout**



6 PCB stack-up

Figure 13. **PCB stackup**

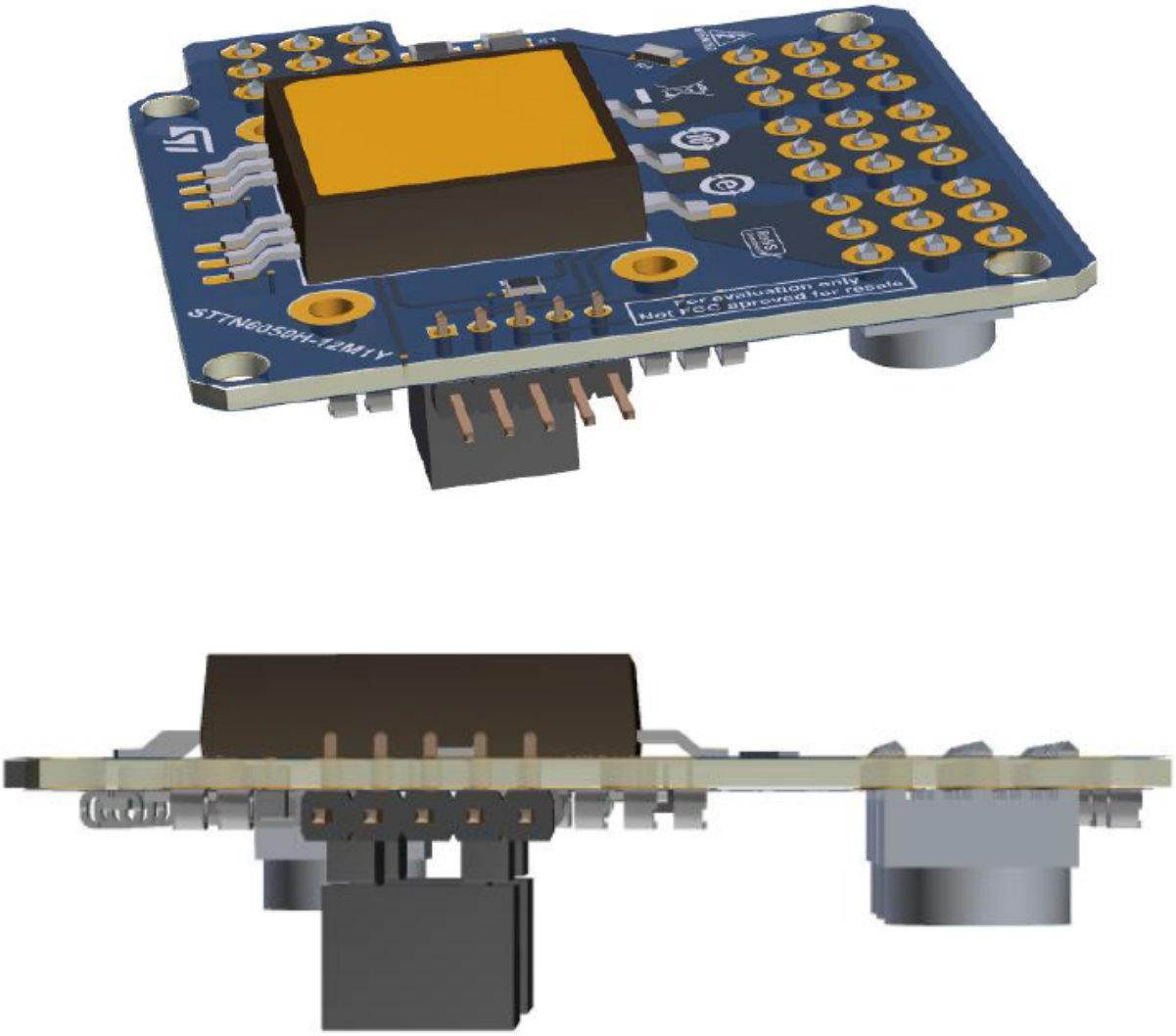


Board Stack Report

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 3D views

Figure 14. **STDES-SSR002V1 3D view**



8 BOM

Table 1. STDES-SSR002V1 bill of materials

Designator	Part / Values	Description
C1	10 nF	Ceramic capacitor, 10 nF X7R / 50 V
C2, G1, G2, L1-, L1+, L2, N,'C1, GND, RG1, RG2, SCR1_ctrl, SCR2_ctrl, VCC, VP1_1, VP1_2, VP2_1, VP2_2, ZVS	N/A	SMD test points
D1, D2, D4, D5, D6	1N4148W-7-F	Fast switching diode, 100 V, 0.15 A, SOD123
D3, D7	BZV55-C6V8	Diode zener 6.8 V, 500 MW
MP1, MP2, MP3, MP6	M4 x 4 mm	WP-THRBU REDCUBE THR internal blind-hole thread, M4 x 4 mm, 85 A
P1	61300511021	THT Angled pin header WR-PHD, pitch 2.54 mm, single row, 5 pins
Q1, Q2	MMBT4401	NPN general-purpose amplifier, 0.6 A, 40 V, -55 to 150 °C, 3-pin SOT-23
R1, R6	51 R	Metal film chip resistor, 0.125 W, +/- 0.1%, 0805 (2012 metric)
R2, R7	2.2 R	Metal film chip resistor, 0.125 W, +/- 0.1%, 0805 (2012 metric)
R3	10 k	Metal film chip resistor, 0.125 W, +/- 0.1%, 0805 (2012 metric)
R8, R9	1 k	Metal film chip resistor, 0.125 W, +/- 0.1%, 0805 (2012 metric)
R4, R5	51 k	Metal chip resistor, 51 kΩ, 0.25 W, +/- 0.1%, 0.25 W, 1206 (3216 metric)
T1, T2	PH2190.021NL	High isolation power transformers - 1800 µH - 2:1
U1	TLP-187	Optocoupler DC-IN darlington output 4-pin mini-flat
U2	STTN6050H-12M1Y	60 A 1200 V thyristor controlled half bridge in ACEPACK SMIT module

Revision history

Table 2. **Document revision history**

Date	Revision	Changes
26-Feb-2024	1	Initial release.
26-Jul-2024	2	Added Getting started.