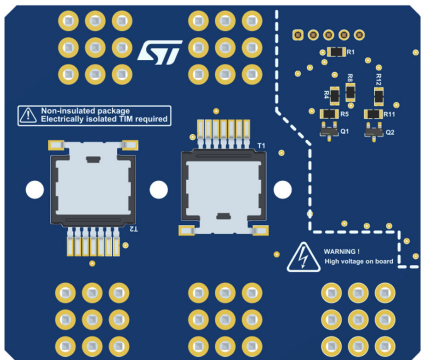
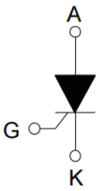
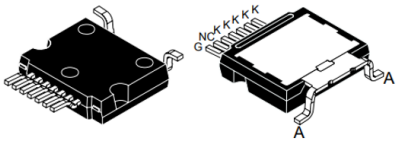
STDES-SSR003V4

Data brief

40 A 1200 V solid state relay with single push-pull driver







TN4050HP-12L2Y

Product summary
STDES-SSR003V4

Key product
TN4050HP-12L2Y

Features

- Two 40 A SCRs TN4050HP-12L2Y
- Package with top side cooling and optimized thermal management
- Ready to test controlled half bridge
- Single insulated gate driver included
- Direct connection to STM32 interface
- Optimized thermal management
- Both SCRs are turned ON together

Applications

- 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-SSR003V4 is a ready to use reference design that features a solid-state relay. The reference design allows us to evaluate TN4050HP-12L2Y as a 40 A switch for automotive and industrial AC applications.

The reference design includes a driving circuit featuring a push and pull driving converter that allows both the SCRs to be turned ON together.

The key product TN4050HP-12L2Y is an automotive qualified 40 A 1200 V thyristor assembled in the top side-cooled package HU3PAK.

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-SSR003V4 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 two 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.*

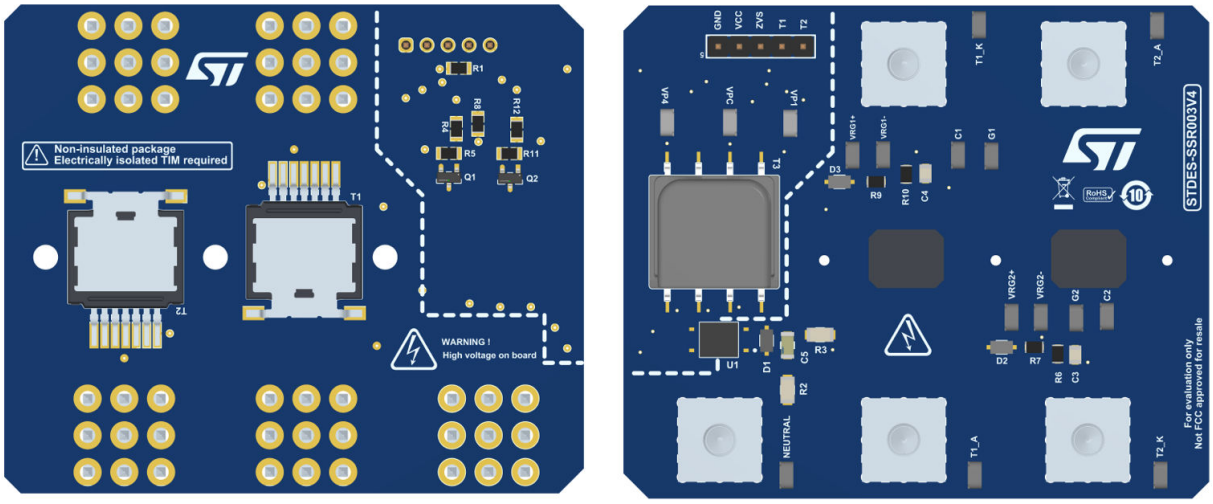
Danger: *Do not touch the evaluation board when it is powered or immediately after it has been disconnected from the voltage supply as several parts and power terminals containing potentially energized capacitors need time to discharge, and heat-sink and transformers may still be very hot.*

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.

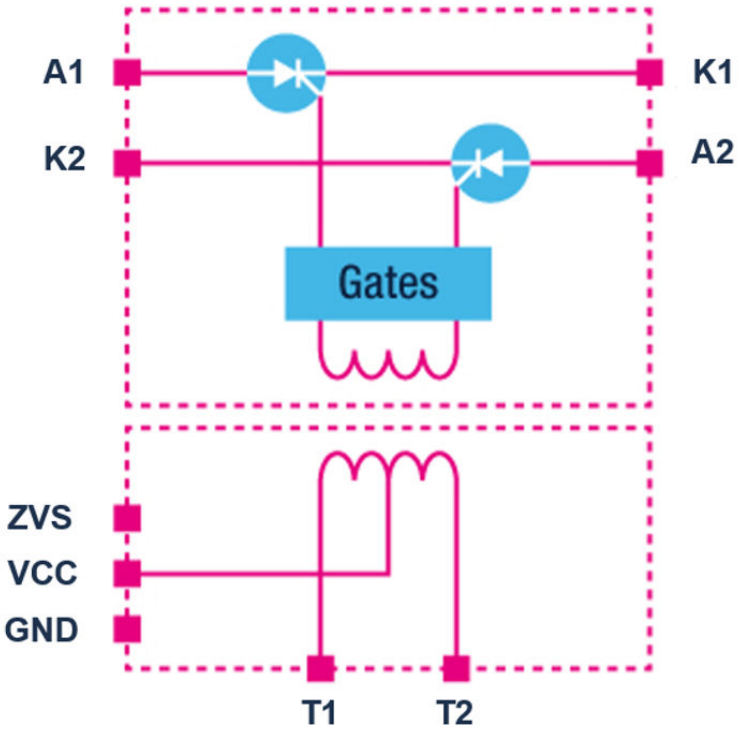
2 Pinout and recommendation

Figure 2. **STDES-SSR003V4 2D view**



The connections to the anodes and cathodes of both thyristors T1_A, T1_K, T2_A, T2_K as well as the neutral should be connected as needed in the AC application.

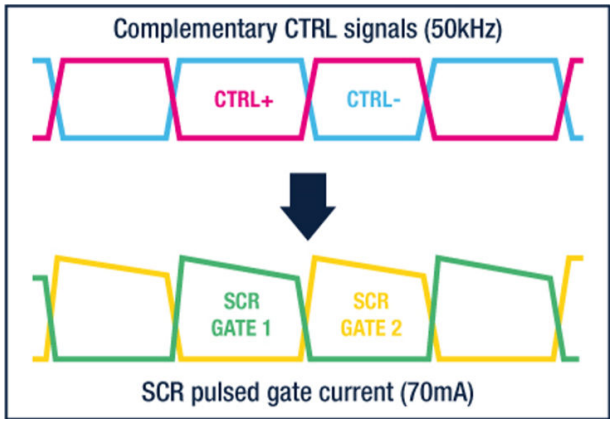
Figure 3. **STDES-SSR003V4 pinout**



To test the reference design, two signals are to be provided from the microcontroller to drive the two thyristors of board T1 and T2.

- GND and VCC are to be connected as well
- ZVS is an output of the board and could be visualized if needed.

Figure 4. **STDES-SSR003V4 thyristors driving signals**

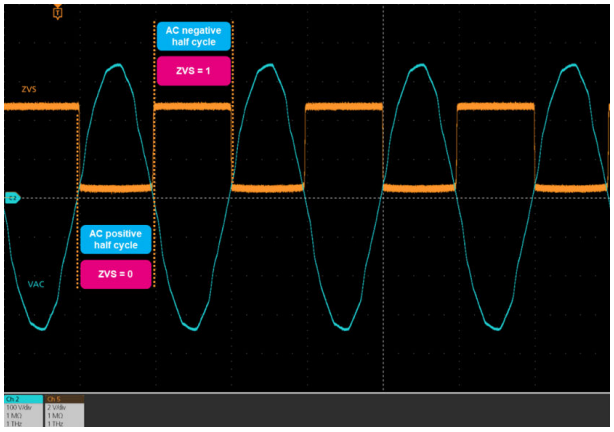


Thanks to the push and pull transformer used in the STDES-SSR003V4, the two thyristors are driven by one single driver, and they are both turned ON together. It is practical for switching applications where thyristors are used simultaneously and where this driving makes the design optimized.

Figure 4, CTRL+ and CTRL- represents the driving signals provided from the microcontroller to drive T1 and T2.

SCR GATE 1 and SCR GATE 2 represents the signals seen at the gate of the thyristors (between the gate and cathode of each thyristor)

Figure 5. **ZVS output signal on STDES-SSR003V4**



The ZVS signal provides the AC voltage polarity information to the MCU to synchronize the SCR driving signal on T1 and T2 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.

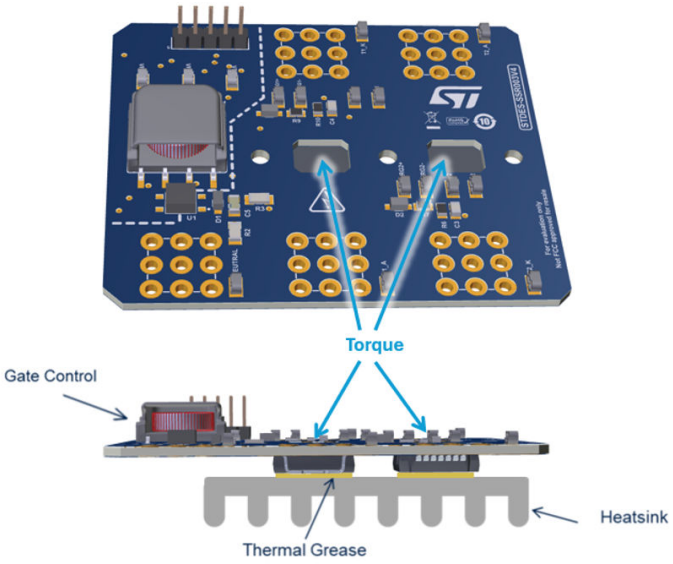
- ZVS level is low during the AC positive half cycle
- ZVS level is high during the AC negative half cycle.

The reference design PCB features openings, underneath the two SCRs TN4050HP-12L2Y, that we recommend.

To attach the two SCRs 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 product and thus protecting the PCB and contact with component pins from mechanical risks that might result from the force applied.

Figure 6. **STDES-SSR003V4 view on the PCB opening**



3 Schematics

Figure 7. **STDES-SSR003V4 schematics**

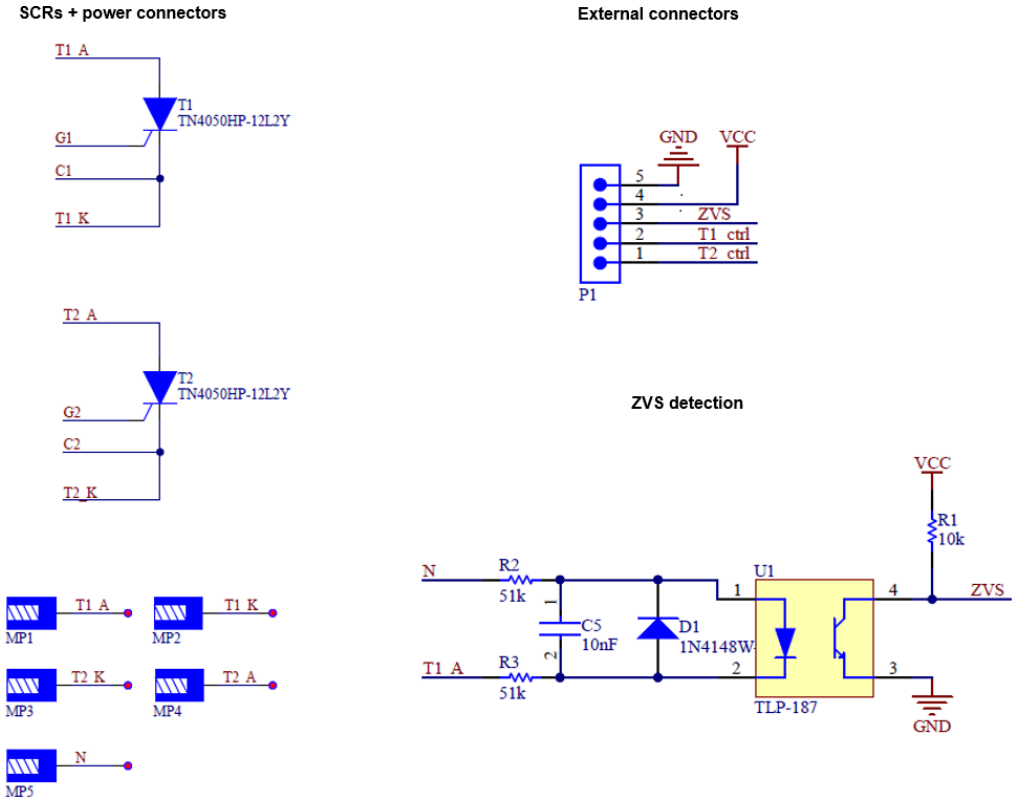
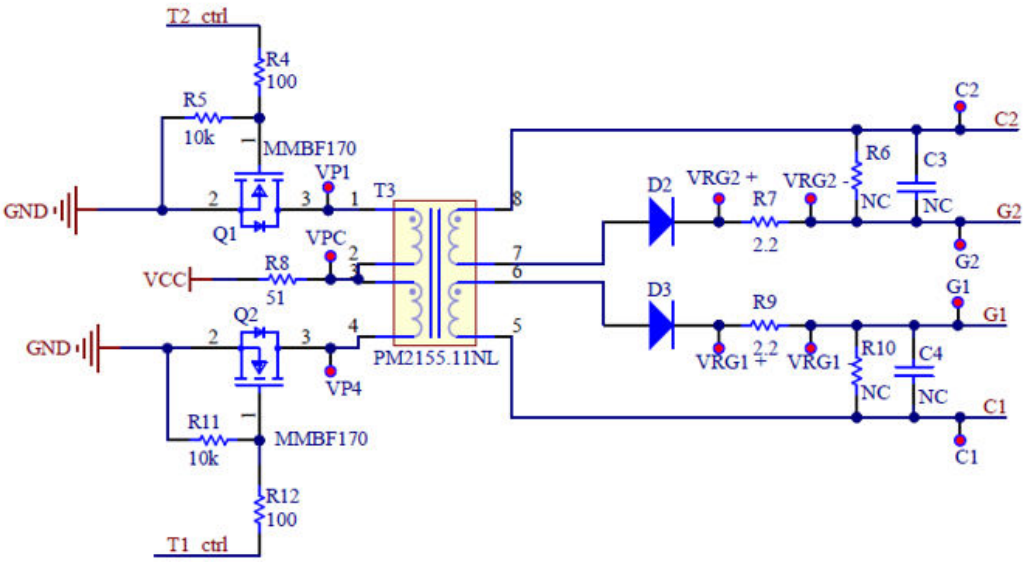
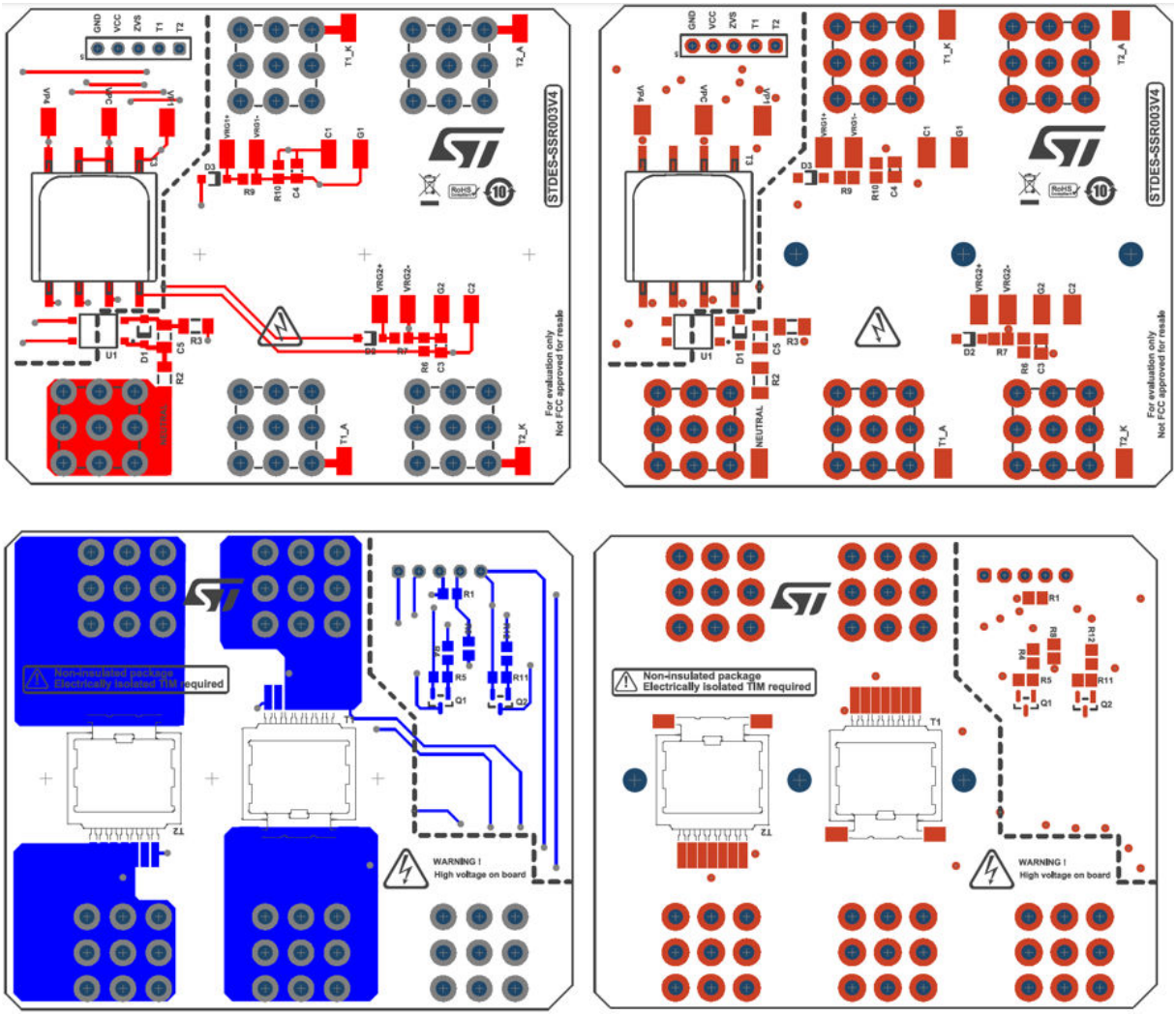


Figure 8. **SCR pulse transformer gate drivers**



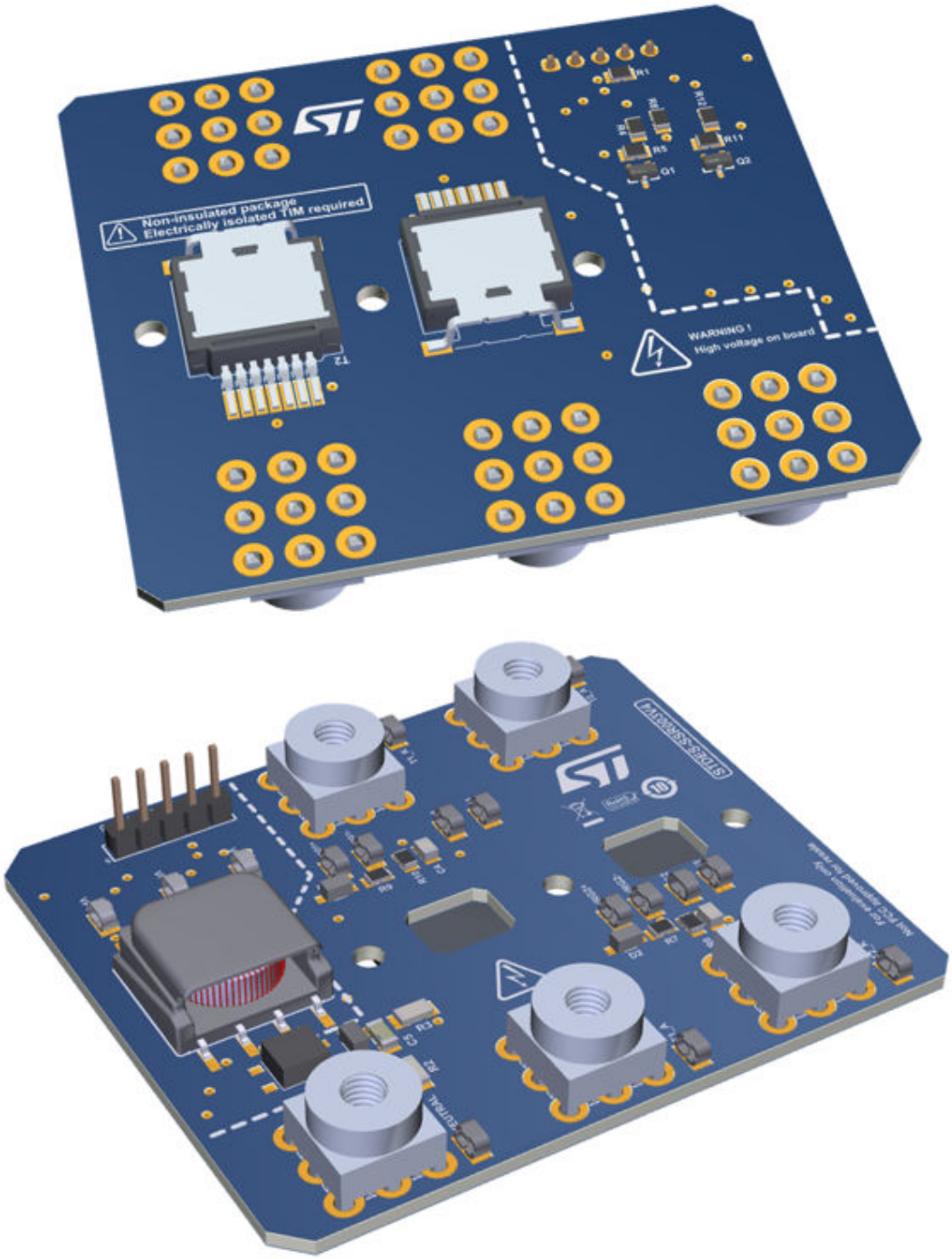
4 Layout

Figure 9. **STDES-SSR003V4 layout**



5 3D views

Figure 10. **STDES-SSR003V4 3D view**



6 BOM

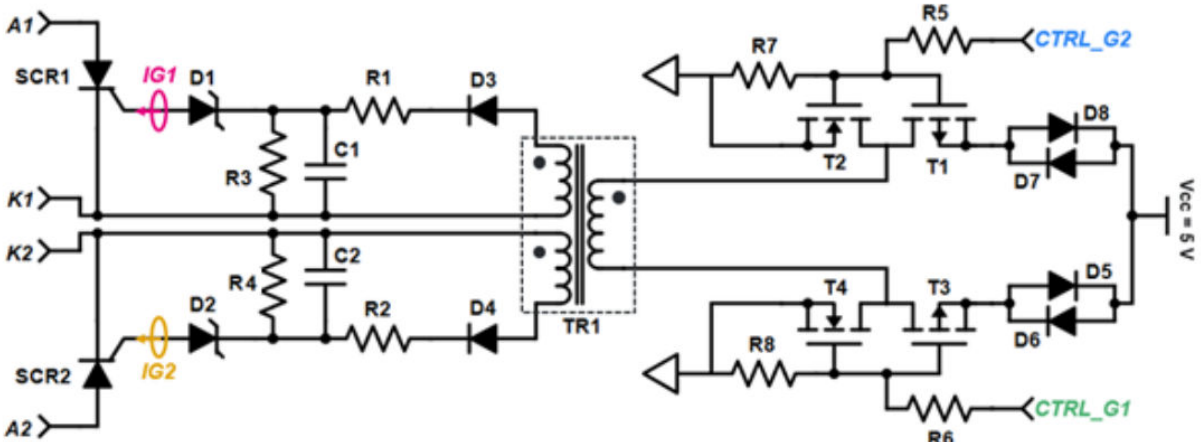
Table 1. **STDES-SSR003V1 bill of materials**

Designator	Part / values	Description
T1, T2	TN4050HP-12L2Y	50 A, HU3PAK automotive SCR
T3	PM2155.11NL	Push pull converter transformer
U1	TLP-187	Optocoupler DC-IN darlington output 4-pin mini-Flat
C3, C4	Optional	Capacitor 10 nF 50 V ± 10 % 0805 (2012 metric)
C5	10 nF	SMD cap 10 nF
D1, D2, D3	1N4148W-7-F	Fast switching diode, 100 V, 0.15 A
C1, C2, G1, G2, N, T1_A, T1_K, T2_A, T2_K, VP1, VP4, VPC, VRG1 -, VRG1 +, VRG2 -, VRG2 +	Test point	
MP1, MP2, MP3, MP4, MP5	M4 x 4 mm	WP-THRBU REDCUBE THR internal blind-hole thread, M4 x 4 mm, 85 A
P1	61300511121	WR-PHD pin header, THT, vertical, pitch 2.54 mm, 1 row, 5P
Q1, Q2	MMBF170	MOSFET N-CH 60 V 500MA SOT-23
R1, R5, R11	10k	Metal film chip resistor, 0.125 W, +/- 0.1 %, from -55 to 155 °C, 0805
R2, R3	51k	Chip resistor, 51 kΩ, +/- 1 %, 0.25 W, from -55 to 155 °C, 1206 (3216 metric), RoHS
R4, R12	100	0805 metal film chip resistor
R6, R10	Optional	0805 metal film chip resistor
R7, R9	2.2	0805 metal film chip resistor
R8	51	0805 metal film chip resistor

7 Independent semiconductor controlled rectifier control

When the SCR needs to be controlled independently, an alternative schematic can be proposed where driving signals (CONTROL_G1 and CONTROL8G2) do not have to be complementary.

Figure 11. Single pulse transformer schematic



This schematic defines a method to control two triac or thyristor independently using a single pulse transformer with two secondary windings. This solution is designed to supply at least 100 mA of gate current, making it suitable for various applications. The primary winding of the pulse transformer is controlled with a pulse-width modulation (PWM) at 10 kHz with a 10% duty cycle. The detailed schematic, bill of material and operational curves to illustrate the described control method is given.

Table 2. Bill of material

Reference	Part
R1 / R2	13 Ω
R3 / R4	1 kΩ
R5 / R6	51 kΩ
R7 / R8	10 kΩ
C1 / C2	680 pF
D1 / D2	2.7 V zener
D3 / D4 / D5 / D6 / D7 / D8	SBR140S1FQ-7
T1 / T3	ZXMP6A17
T2 / T4	ZVNL110G
TR1	PM2155.012NL

Table 3. Electrical details

Reference	Definition	Value
VCC	DC power supply	+5 VDC
CNTRL_G1 CNTRL_G2	PMW control signal	PWM control Frequency = 10 kHz Duty cycle = 10% Amplitude = +5 VDC

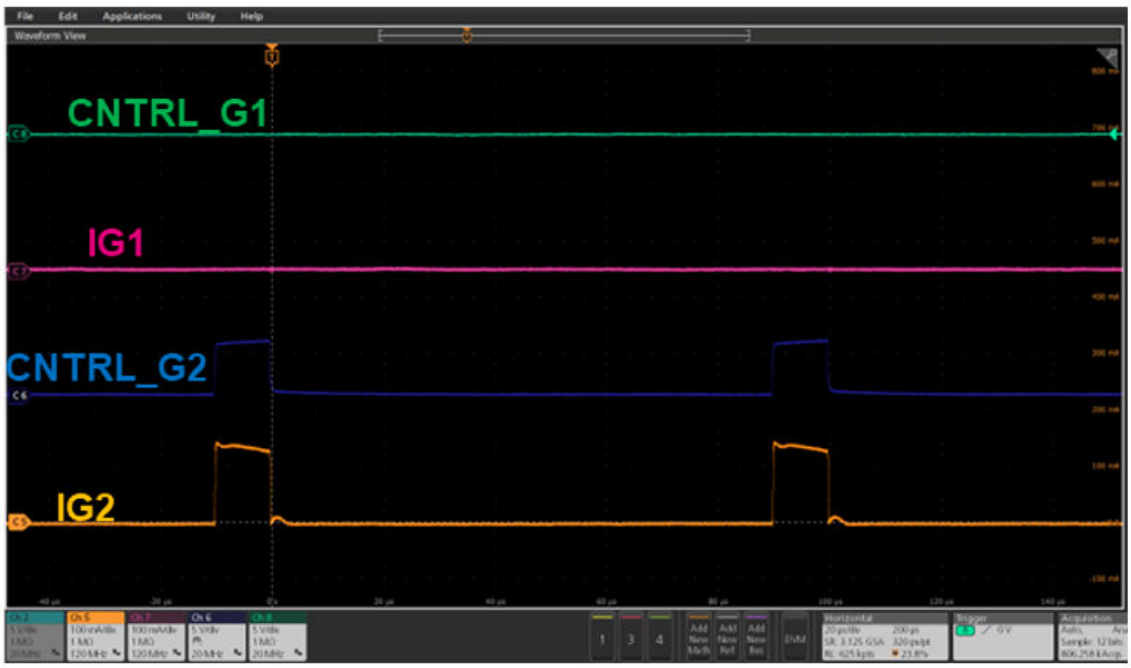
The following scope capture illustrates the circuit configuration for controlling SCR1 and SCR2 using a single pulse transformer.

When only SCR1 is controlled, the CNTRL_G1 signal is modulated using PWM, while CNTRL_G2 is pulled to GND via resistor R7.

Figure 12. Configuration for controlling SCR1

When only SCR2 is controlled, the CNTRL_G2 signal is modulated using PWM, while CNTRL_G1 is pulled to GND via resistor R8.

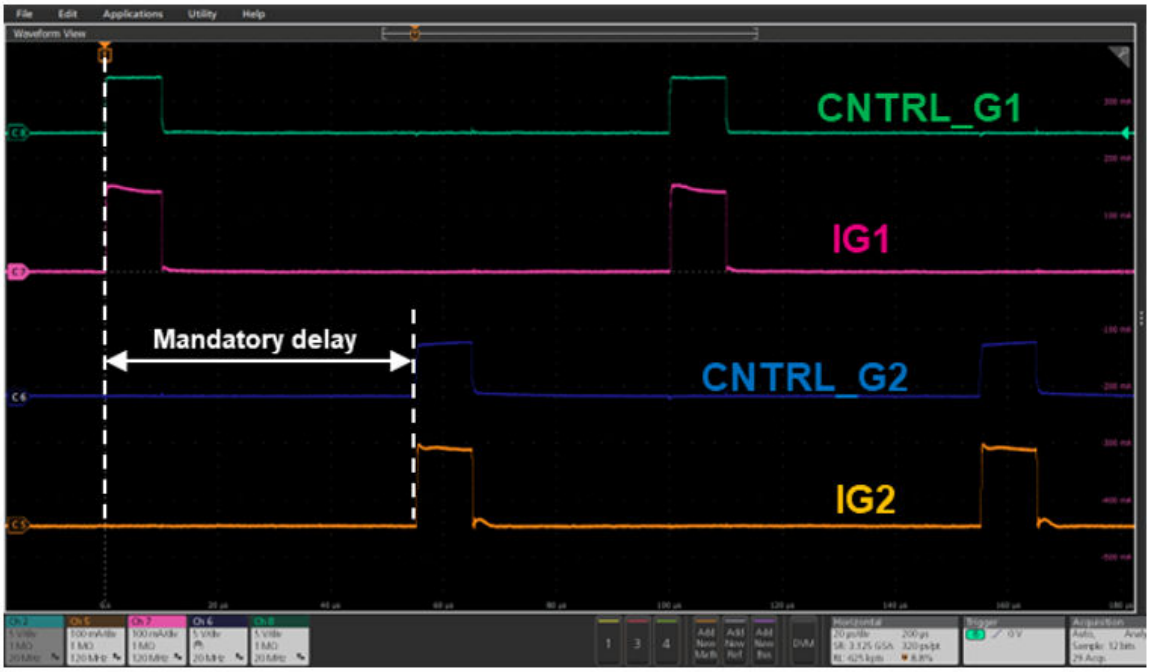
Figure 13. **Configuration for controlling SCR2**



When both SCR1 and SCR2 need to be controlled, CNTRL_G1 and CNTRL_G2 signals are modulated using PWM. CNTRL_G1 and CNTRL_G2 signals are shifted from each either to ensure proper operation of both SCRs control.

This allow to ensure a full demagnetization of the pulse transformer to control SCR1 and SCR2.

Figure 14. **Configuration for controlling SCR1 and SCR2**



Revision history

Table 4. **Document revision history**

Date	Revision	Changes
05-May-2025	1	Initial release.
22-Sep-2025	2	Added Section 7: Independent semiconductor controlled rectifier control. Minor text changes.

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