How safe is your test station really?

Let's talk about the safety circuit!

First Things First – What is an Electrical Safety Circuit?

A safety circuit is a technical protection system that ensures hazardous voltages or currents are only enabled when all safety-related conditions are met. It continuously monitors conditions such as door interlocks or two-hand operators, and immediately cuts off the power supply if a hazard is detected or a protective device is opened.

“What Test Stations Can Learn from Aircraft.”

In aviation, the rule is clear: even if a system fails, the aircraft must not crash. This is why aircraft are equipped with multiple redundant systems. The same principle applies to safety-critical areas using high-voltage test equipment operating at potentially lethal voltages—without safety systems, an undetected fault can have fatal consequences.
For this reason, EN 50191 (“Erection and Operation of Electrical Test Installations”) also requires the use of safety solutions capable of reliably detecting the *first fault* and then bringing the system to a safe state. Ultimately, such solutions ensure that aircraft remain safe in flight—and that industrial installations can be operated without accidents.

*DIN EN 50191 VDE 0104:2011-10

“Who is responsible for safety at the test station?”

According to EN 50191*, responsibility for the safety of the test installation and the entire test area lies with the operator. Careful planning, including a risk assessment and hazard assessment, is therefore essential.

A standard-compliant safety circuit is mandatory whenever hazardous insulation resistance tests or high-voltage tests are carried out. Even for protective conductor current tests or functional tests, the use of a safety circuit may be required.

*DIN EN 50191 VDE 0104:2011-10

According to **DIN EN ISO 13849**, an electrical equipment must be provided with a device which, in the event of an imminent hazard, will shut down the system or part of it — this is precisely the function performed by the safety circuit.

Buying safely means: Pay attention to the safety circuit!

When purchasing a high-voltage test instrument, the safety circuit must not be an afterthought — it is a central element of functional safety. What matters is that this protective circuit is not only present, but also certified and properly implemented.

Some solutions require the user to build the safety circuit externally — a high effort with increased risk in design, implementation, and documentation.

Many common solutions do not follow the principles of safety. In most cases, there is only a single input for the control circuit of the safety circuit, and the internal design is not dual-channel — the so-called first fault is not detected at all.

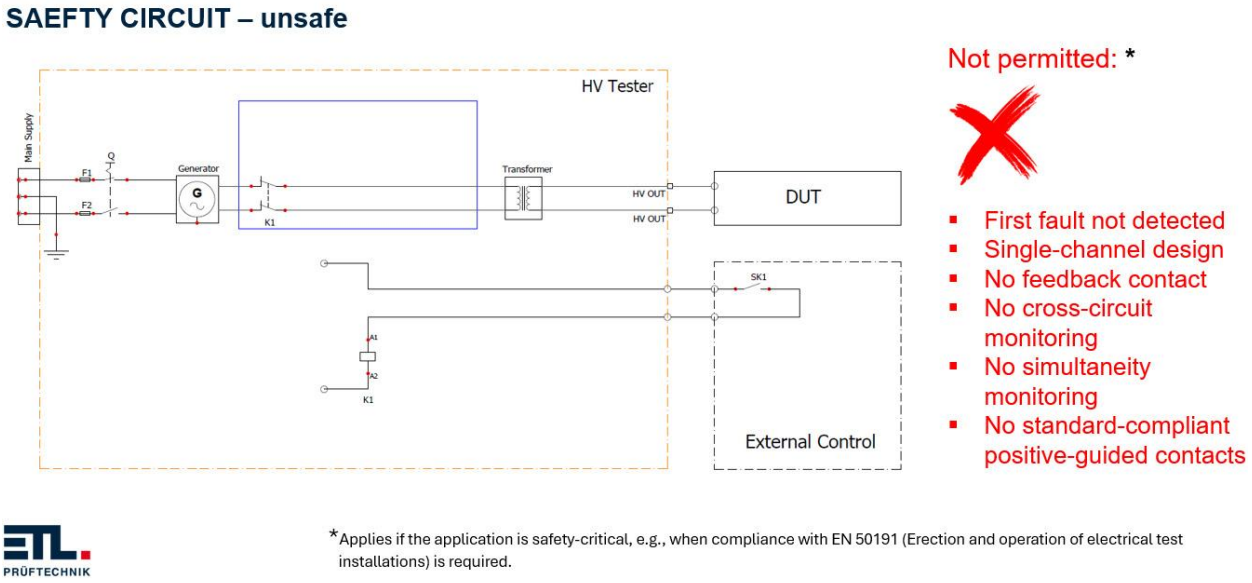

Figure 1: Safety circuit not permitted implementation

SAFETY CIRCUIT – Verify the safety of your test team in production and laboratory environments based on the following features:

Main requirement: The first fault must be detected!

- Standard-compliant implementation according to EN ISO 13849-1, EN 61508 / EN 62061, or EN ISO 13851 (two-hand control devices)
- Simultaneity monitoring and cross-circuit monitoring of the control circuits
- Safety circuit implemented as dual-channel within the power circuit of the test system
- Safety relays designed in accordance with DIN EN 61810-3:2016-01 (positive-guided)
- Safety relays equipped with forcibly guided feedback contacts
- Certified performance data available for risk assessment and hazard analysis

Since 2019, the safety circuit in the ATS400 has also been **externally certified*** by TÜV Nord and meets safety levels **SIL3**, **PLe**, **Category 4**, and **IIIc** — without any additional external setup, ready for operation and fully documented.

* The SHK-ATS has been tested according to the following standards:
EN ISO 13849-1:2015, EN 61508-3:2010, EN 574:1996+A1:2008,
and EN 62061:2005+Cor.:2010+A1:2013+A2:2015.

The safety circuit from ETL Prüftechnik reliably **detects the first fault** and then disconnects the power supply to the device under test — a closer look at its design reveals how this high standard is achieved.

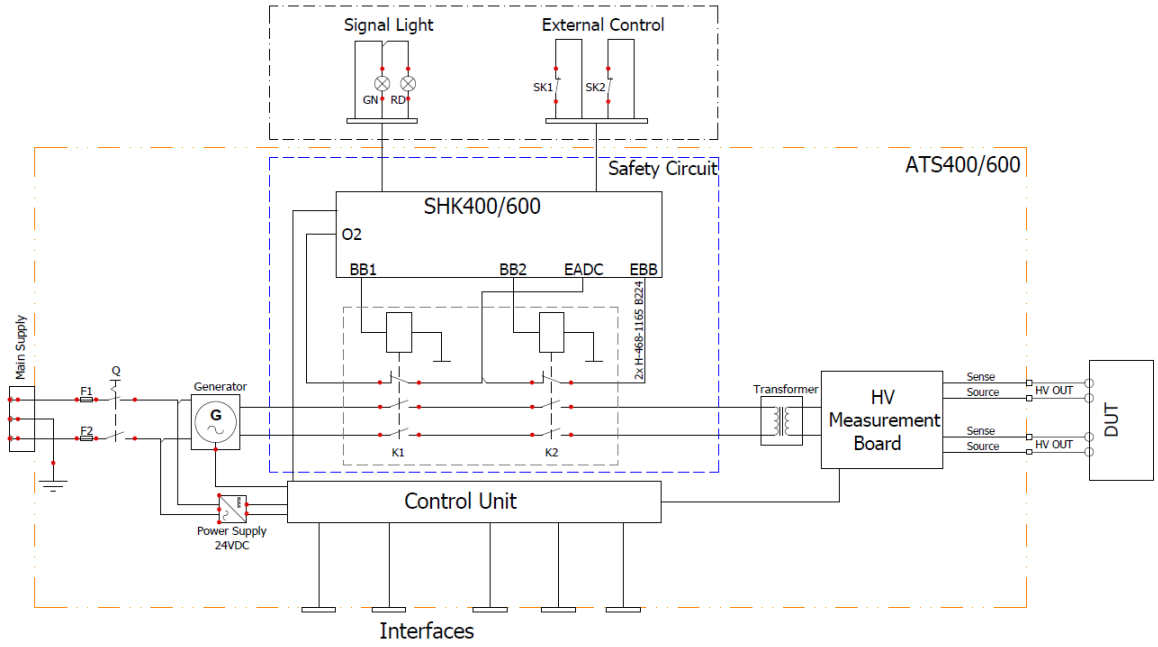

Figure 2: Safety circuit (SHK) inside high voltage tester ATS400

1. Dual-Channel Design with Safety Relays

The safety circuit is located on the primary side of the high-voltage transformer. Here, two safety relays are connected in series and operate independently of each other — this forms the basis of the dual-channel design.

Both relays are certified safety relays with **positive-guided contacts**: the power contacts, which switch the hazardous voltage on and off, are mechanically linked to a **forcibly guided** monitoring contact.

This means: only if both power contacts are in the same state will the feedback contact report “no fault.” In this way, for example, a welded relay contact (*first fault*) can be reliably detected before anything happens.

2. Separate Digital Evaluation

The feedback signals from the relays are evaluated by two processors of different architectures. In addition, two independent software solutions are used. The safety circuit remains active only when the results of the two evaluation units match completely.

And What Happens in the Event of a Fault?

If a fault is detected, the safety circuit immediately switches reliably to the **fail-safe** mode. The relay contacts open, and the power supply to the device under test (DUT) is reliably disconnected.

Depending on the type of test, the shutdown behaviour differs:

- **AC Tests:** When the power supply is interrupted, the HV transformer and the DUT discharge automatically (due to physical principles).
- **DC Tests:** The system's integrated active discharge function and discharge monitoring are employed. They ensure that stored energy is reliably dissipated even in the event of a fault.

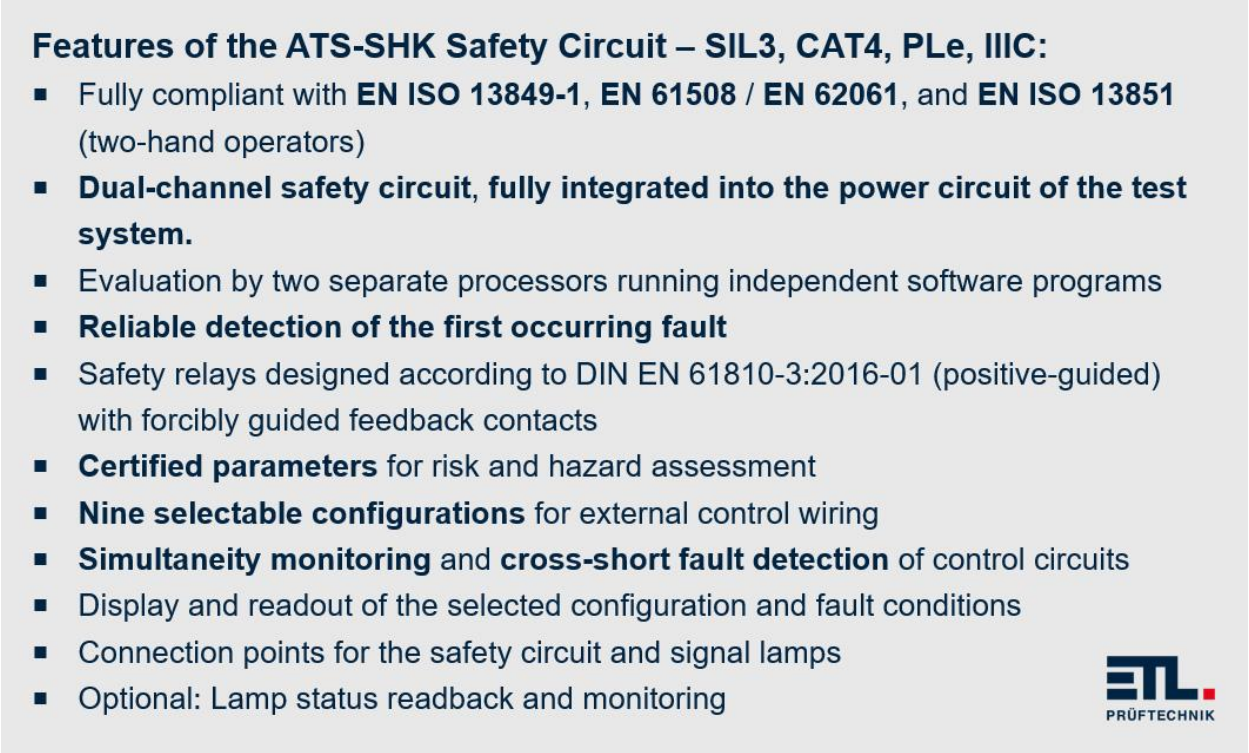

Figure 3: Features safety cicuit ATS400

Getting Specific: Configuration & Wiring of the Safety Circuit

The technical challenge in implementing a safety circuit lies in achieving complete fault detection: each output must have **cross-circuit monitoring** to all other outputs — every potential *first fault* must be reliably detected.

A total of **nine certified configurations** are available. All meet the requirements of the highest safety level: **SIL 3, PL e, Category 4**. The only exception is the configuration with

safety test pistols — this still achieves a very high level with **SIL 3, PL d, Category 2**, as the safety circuit is closed manually by the operator in this case.
The various configurations are designed for typical practical applications at the test station:

- **Configuration 1:** for two-hand control devices
- **Configurations 2 and 3:** ideal for test enclosures
- **Configuration 4:** suitable for automation solutions
- **Configuration 5:** ideal for manual testing with test pistols
- **Configuration 6:** for use with safety PLCs
- **Configurations 7, 8, and 9:** with guard locking that only releases after the test has been completed

A detailed description of all variants can be found in the ATS400 user manual, Chapter 7.

The following is a brief introduction to configurations 1, 2, 4, and 6. In all configurations with simultaneity monitoring, if simultaneity is violated, the enabling circuits will not close and the system will wait for a correct switching sequence.

- **Configuration 1: Two-Hand Control with 2 Changeover Contacts**
  - This configuration is suitable when the test station is set up without inherent contact protection. The two-hand control ensures that the operator maintains a safe distance from the device under test (DUT).
  - Type III C, Category 4, SIL 3, PL e
  - Simultaneity monitoring: 0.5 s

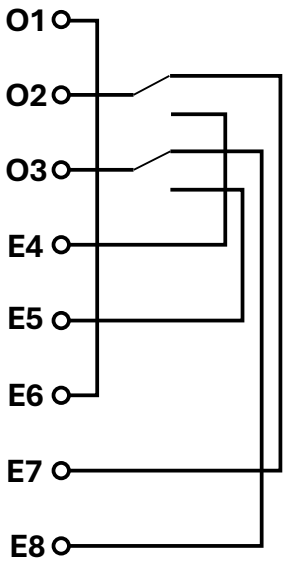

Figure 4: Configuration 1 – The two-hand control must not be activated when switching on..

- **Configuration 2: Safety Door / Test Enclosure with 2 Normally Closed Contacts**
  - Configuration 2, as well as Configuration 3, is used when the test station has inherent contact protection in the form of a test enclosure.
  - Category 4, SIL 3, PL e
  - Simultaneity monitoring: 2.5 s

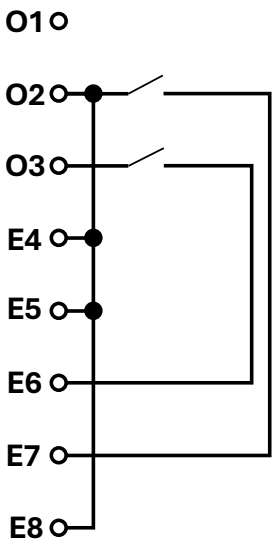

Figure 5: Configuration 2 – The switch position corresponds to the door being open.

- **Configuration 4: Safety Door – Automation Solution**
  - This configuration is frequently used in plant engineering
  - It is also suitable for switch simulation via a safety PLC.
  - Typical application: In automated systems, maintenance doors can remain permanently closed while start is still permitted. This is not allowed with Configurations 2 and 3 using test enclosures.
  - Category 4, SIL 3, PL e
  - Simultaneity monitoring: 2.5 s

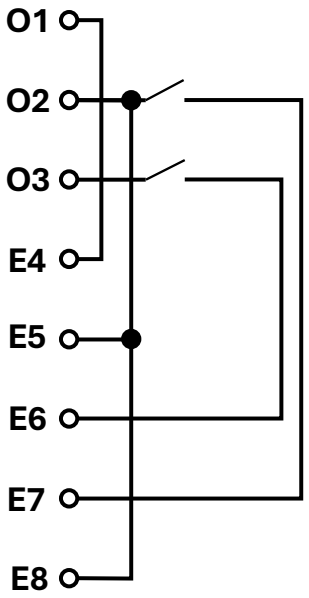

Figure 6: Configuration 4 - The switch position corresponds to the door being open.

- **Configuration 6: Intelligent Switch (OSSDs)**
  - Application: For safety PLCs with pulsed OSSD signals.
  - Intelligent switches transmit pulsed signals; the system detects signal deviations by evaluating the phase between the signals.
  - Enhanced cross-circuit monitoring.
  - Direct connection of light curtains possible — no additional switching device required, resulting in a cost advantage.
  - Category 4, SIL 3, PL e
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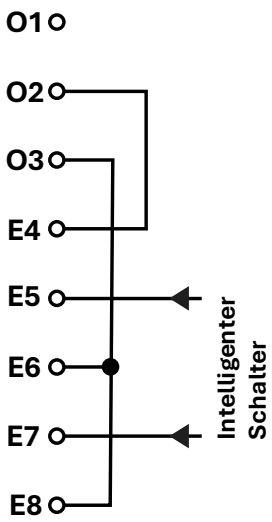

Figure 7: Configuration 6 – Cross-circuit monitoring (E5 and E7) is handled by the intelligent switch.

Good to Know:

Optional — but typical for ETL: dual-channel monitoring also for the signal lamp.
Optionally, the condition of the lamp can also be monitored on a dual-channel basis.
A separate socket is available for the signal lamp. Control is provided directly by the safety circuit — not only via the software.