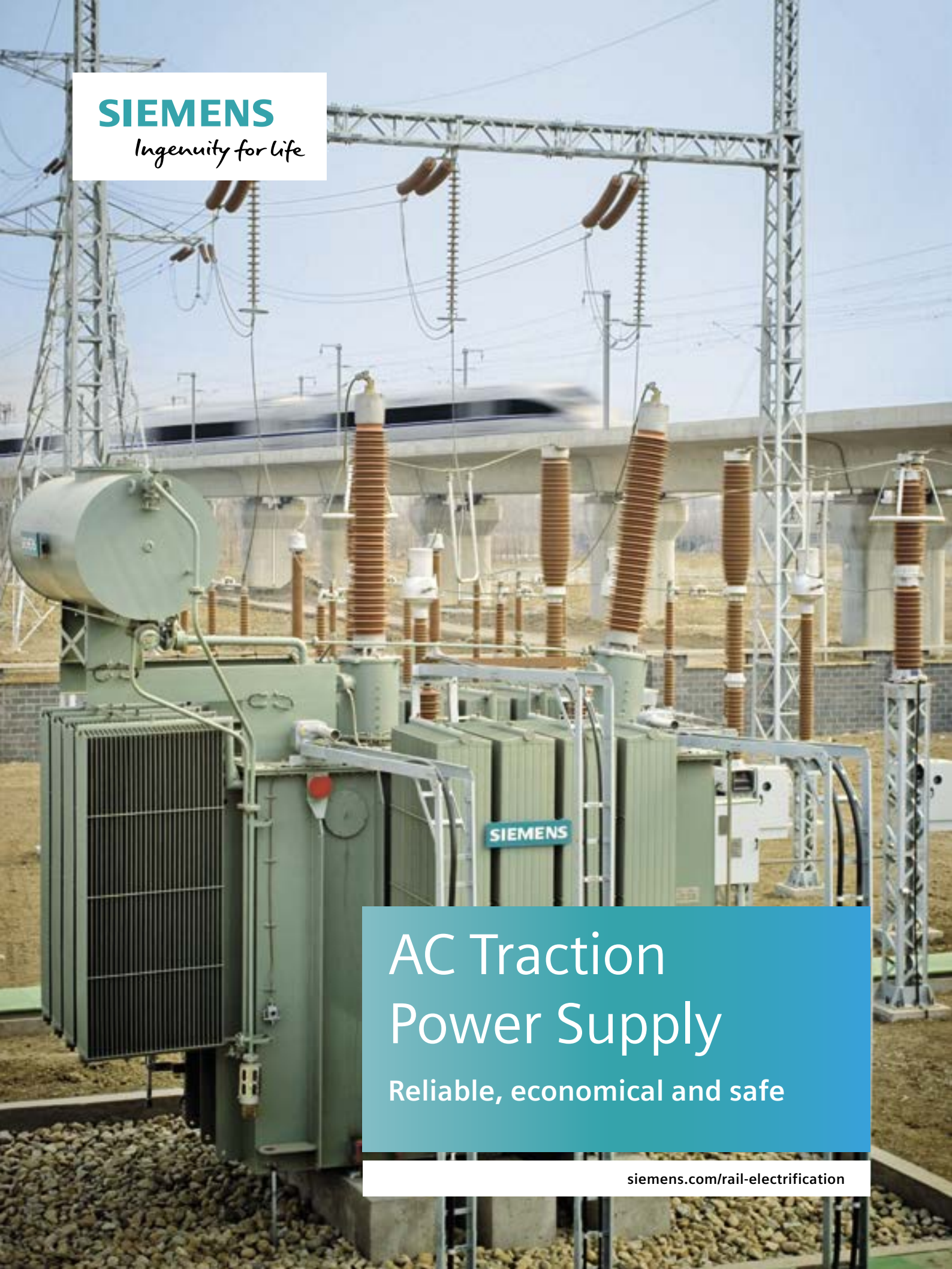


SIEMENS

Ingenuity for life

AC Traction Power Supply

Reliable, economical and safe

siemens.com/rail-electrification

More people, new challenges, one solution: Integrated mobility.

Demographic change, urbanization and climate change: these are the global trends of today and tomorrow. For the world population is not only growing, it's also getting older. Current forecasts expect it to rise to 9.2 billion by 2050.

These people will need efficient transportation and logistics. And that calls for innovative electrification solutions.

Needed more than ever before: efficiency and sustainability

Not only the world's population will continue to grow in the coming years, urbanization will also be on the increase. So much so that experts are predicting that 90 percent of future population growth will be concentrated in cities.

Such trends mean however that traffic densities all over the world will likewise increase – and with them the demand for intelligent, sustainable solutions for mobility.

Intelligent and efficient rail electrification solutions

Concepts that make transport more efficient are in demand with the ever-increasing need for mobility. With our long-standing transport-expertise and out IT know-how, we are constantly developing new, intelligent mobility solutions that increase availability of infrastructure, optimize throughput and improve passenger experience. It´s in how we electrify, automate and digitalize infrastructure that we´re setting the benchmark for tomorrow´s mobility – today.

Optimal service – a competent partner

You can benefit from our decades of experience in the engineering, construction and commissioning of AC traction power supply systems. As one of the world's leading suppliers of electrotechnical plants and innovative technology partner to all major rail operators, we offer you all services from a single source and enable you to tap a lot of potential savings. Therefore, our traction power supply systems are not only reliable but also energy-efficient and capable of carrying heavy loads.

Our engineering tools uncover open questions as early as the project analysis phase. Place your trust in our ability to take a good component and make an even better traction power supply system.

When it comes to regional and main-line railways, we are the right partner for your AC traction power supply, for consultation and planning, for project implementation and commissioning, and for worldwide service.

Perfectly planned, perfectly implemented: Reliable solutions from one source

Our traction power supply systems are as diverse as the trackside facilities which they have to feed.

This is why we start our work with a thorough analysis of all the static and dynamic aspects of your project.

Profit from a partner who knows how to take all eventualities in account in advance and who avoids unpleasant surprise, before the first ground is broken.

Maximum benefit

The most important parameter in planning a new AC traction power supply is your energy requirement, for the key to future economical operation lies in the total number, location and output of the substations. Of course, we also show you the alternatives and, on request, include a possible subsequent service expansion in our plans.

Our calculations are based on your invitation to tender. The essential parameters for the positioning of the substations are:

- Voltage drop on the overhead contact line
- Availability of the network connection points
- Operation in case of substation failure
- Power losses
- Topographical conditions
- Operating concept

Knowledge instead of assumptions

To be able to give you clear information about the economic feasibility of your traction power supply before you make your investment, we have developed Sitras® Sidytrac, a software application which calculates the characteristics of your AC traction power supply on the basis of train operations.

This network calculation is based on a train movement simulation, which even takes into account the interactions between the vehicle and the overhead contact line system. The effects of the regenerative feedback on the national grid are also simulated. This enables us to determine and evaluate power consumption, regenerative behaviour and potential energy savings of the planned system under realistic conditions. This places your investment decision on a solid footing.

Planned safety

The earthing network and the return current circuit planning also includes the calculation of the impedance ratios, from which the tapping voltages are determined.

The high- and medium-voltage systems are dimensioned according to requirements. This planning also takes into account:

- The traction power supply,
- The low voltage system,
- The external lightning and overvoltage protection, as well as
- The earthing of buildings, structures and infrastructural facilities.

An in-depth EMC analysis provides the basis for the assured safety of persons and installations at all times.

To calculate the magnetic fields we rely on the software tool Sitras EMC. If there is any possibility of interference, for example, from research centers, hospitals, traffic signal systems or in the case of a parallel alignment of AC and DC railway lines, we offer you appropriate countermeasures and explain their effects.

Where everything's just right: Power and safety for main-line and regional rail service

When dimensioning your AC traction power supplies, it is important to take the specific requirements of main-line and regional rail service into account.

These are, on the one hand, the long distances between stations and, on the other hand, the high ratings and speeds involved in passenger traffic and the great expanse of the route network.

AC substations

The transformers in the substations convert the supply voltage from the national grid or the railway's own high voltage power system into the required system voltages, which are usually 15 or 25 kV AC (other supply voltages are also possible).

We offer you individually optimized systems so that the AC substations meet the characteristic requirements of rail service.

Optimally matched: primary and secondary systems

Our primary system in the substation provides a reliable, low-reaction connection to the network and safeguards the supply of power to your railway. The high-voltage switchgear is connected to the national grid or the railway's own high-voltage power system, a transformer steps down the voltage and the medium-voltage switchgear feeds it to the overhead contact line.

On request, we coordinate the connections with the individual power utilities. When it comes to the control and protection functions of the secondary system, we count on our proven Sitras, Siprotec® and Simatic® product families to ensure a particularly reliable and constant power input into the overhead contact line.

Economy follows function

Even if there are many different alternatives available for the design of your power distribution systems, we put top priority on the safety and reliability of the supply system.

Because only those systems that work reliably are economical.

Which system is the most suitable depends on the requirement profile of the particular route. How much power has to be available? How is the return current circuit designed? What restrictions are there in terms of electromagnetic compatibility?

The best alternatives

In AC railways, the return current flows back to the substations through the running rails and earthing system. The standard system comprises a 1 x 25 kV substation and additional return-line cables mounted on poles.

The booster transformer system, however, would be chosen for routes with higher requirements in respect of interference voltages and low power requirements, while the system with 2 x 25 kV autotransformer stations is preferred on high-speed and high-performance routes.

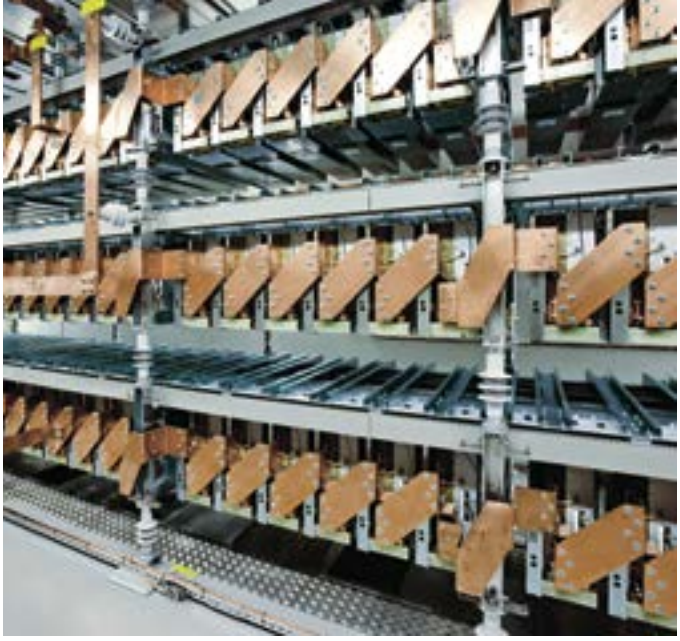
Exactly what you need

We construct your power distribution system to match your needs exactly. And, of course, we also take into account existing infrastructures, buildings, etc. We always erect the substations as close to the track as possible in order to avoid long cable routes and the associated energy losses.

The compact size of the substations enables them to be installed in existing buildings, prefabricated buildings and containers. Particularly installation in a container reduces costs. On-site assembly and commissioning work is generally limited to the external connections. Container solutions are also flexible installations which offer the option of reuse somewhere else at a later date, depending on how needs change.

Higher voltage quality, greater sustainability: Green power supply for railways from public grids

Continuing growth in rail traffic raises the question of how the additional electrical load can be covered sustainably from renewable sources of energy via the public grid. To meet this need, Siemens has developed an integrated solution consisting of static frequency converters, active balancers, and static reactive power compensators based on the multilevel technology. The solution offers increased efficiency, reduced noise emissions, a smaller footprint, and significantly lower maintenance effort.



Sitras SFC plus: the static frequency converter

The Sitras SFC plus static frequency converter was developed based on self-commutated modular multilevel converters. It allows electricity from renewable sources of energy in the public grid to be used in traction power supplies. In addition, it couples the two grids directly with each other using just one power converter. That's why it is named modular multilevel direct converter (MMDC).

Thanks to this newly developed technology, the converter can be adapted modularly to the required supply power and can be used for power levels between 12 MVA and 120 MVA. In contrast to the previous externally commutated direct converters, the self-commutated Sitras SFC plus directly converts three-phase AC from the public grid to the single-phase AC required for the traction power supply network with a different frequency – with nearly no perturbations to the public grid.

Further benefits include the small footprint and the reduced noise emissions of multilevel technology. Moreover, the Sitras SFC plus can also feed traction power supply networks that contain high current harmonics, such as those created by older thyristor-controlled rolling stock, without additional filters. If the network operator demands filters and reactive power compensation equipment, we offer to do the designing and engineering for you.

Active balancer

The active balancer helps you to prevent asymmetry in the public three-phase grids when high levels of single-phase power are drawn for the traction power supply. It compensates also the reactive power of the traction system and thanks to the multilevel technology produces extremely little feedback to the grid.

Without the active balancer, operators would have to connect to grids with higher short-circuit power. Grids with 230 kV or even 400 kV however are not available everywhere. The new construction of a grid connection is associated with considerable time and cost efforts.

Mobile reactive power compensation

The mobile reactive power compensator based on voltage-source-converter-technology controls the catenary voltage to the desired value and increases the voltage quality in the railway net.

Thanks to most modern high power transistors (IGBT) the system is continuously controllable. Also it uses the same modular multilevel converter technology as the static frequency converter Sitras SFC plus. That's why this system is generating a voltage which is nearly a perfect sine wave. This technology also allows the integration of the necessary power into a standard high cube container.

The benefits of the modular system:

- The static frequency converter flexibly converts voltage and frequency
- The active balancer prevents asymmetries when the single-phase load is connected to the public three-phase grid
- Mobile reactive power compensators improve the voltage quality in the traction power supply network
- The integrated system offers the right response to any challenge – cost-effectively and reliably

Future-oriented traction power supply: The system and its components

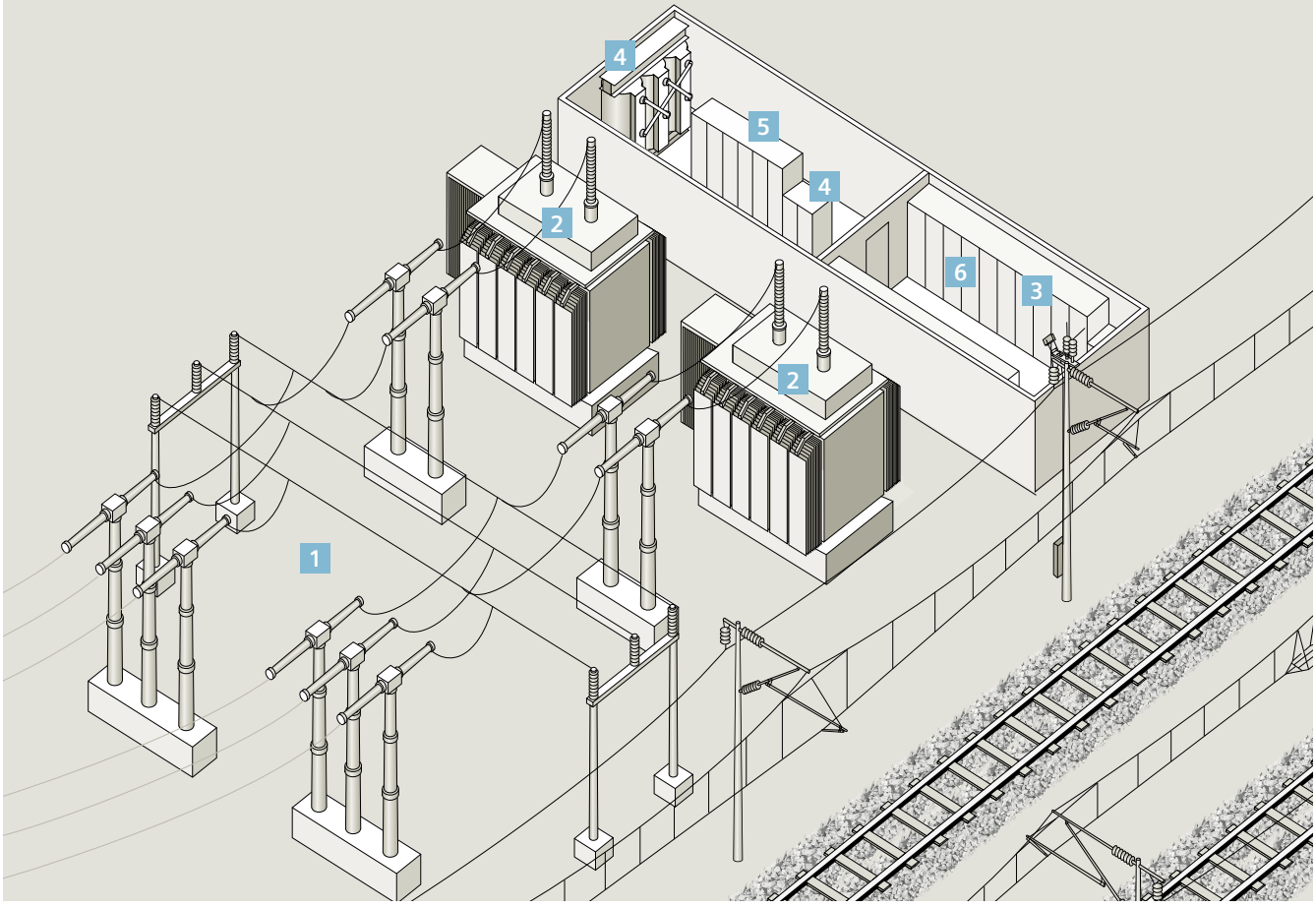
Holistic system solutions offer many advantages, above all when they come from an experienced supplier like Siemens.

All components of the primary and secondary systems are perfectly matched to each another without any interfacing problems. And they can be upgraded to the latest state-of-the-art at any time in order to protect your investments.

Impressive down to the last detail

Profit from our system know-how and our qualified individual components. We can supply you with the complete technology from a single source:

1. High-voltage switchgear
2. Traction transformer
3. Medium-voltage switchgear
4. Auxiliary power system
5. Station control system
6. Siprotec protection technology



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