WHITEPAPER 1500 V

TRUE 1500 V TECHNOLOGY FOR THE NEW GENERATION OF PV POWER PLANTS

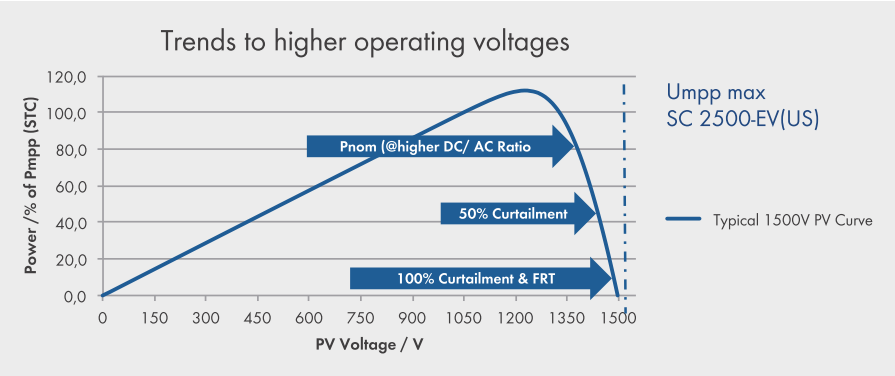
Greater annual yields and higher availability thanks to optimized Stack Design

Large PV power plants in the gigawatt range already supply entire metropolises and regions with electricity in the world's sunny regions. Projects of this size are designed to last for decades. The inverters play a decisive role as a central element in the conversion of electricity into current suitable for the grid. Only technologies specifically designed for high voltages and special conditions meet the highest reliability and runtime requirements here. Deficits in inverter technology that lead to failures and yield losses have a negative impact on the performance of the PV power plants.

Today, PV power plants are used much more frequently at higher DC voltages, close to the open-circuit voltage (1500 V DC). The reasons behind this are the trend towards increasingly higher nominal DC/AC power ratios, the need to quickly curtail PV power plants as well as fault-ride-through events, in which the inverter must still cycle directly in open-circuit voltage. These factors impair the stacks' service life. A high Design Reserve in the stacks is absolutely essential for fault-free operation throughout their service life.

Keyword: Design Reserve

In developing the new Sunny Central inverters with true 1500 V technology, SMA therefore attached considerable importance to a high Design Reserve, which is fully in keeping with the durability of large PV power plant projects and thus guarantees failure-free operation throughout its service life.

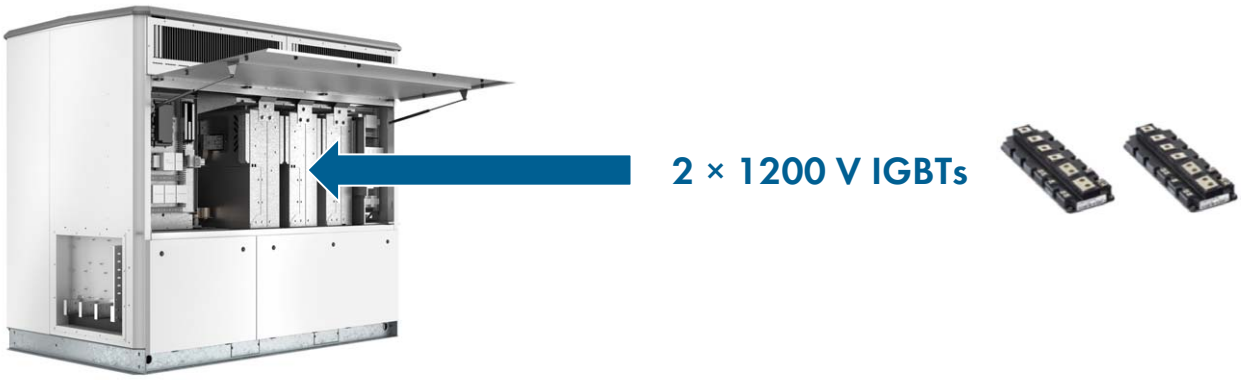


38% DESIGN RESERVE
ENSURES HIGHER AVAILABILITY AND A LONGER SERVICE LIFE

The SMA Sunny Central 2500-EV and 2500-EV-US inverters were designed specifically for 1500 V PV power plants. For each stack, six IGBTs are used, in three groups of two transistors connected in series. The Sunny Central 2500-EV inverters thus have 2400 volt (2 × 1200 V IGBTs) dielectric strength and a Design Reserve of 900 V or 38% compared with other inverters for 1500 V DC voltages. Typically, only a 1700 V IGBT is used. SMA inverters thus enable true 1500 V DC voltages.

The advantages

- Tried-and-tested, robust stack topology for availabilities of more than 99% over 25 years
- Up to 100% curtailment to guarantee all operating points
- Unrestricted continuous operation possible at high DC voltages of up to 1425 V DC



SMA DESIGN RESERVE
REDUCES THE INVERTERS' PROBABILITY OF FAILURE TO ALMOST ZERO

The SMA Design Reserve takes into consideration the IGBTs' resistance to cosmic rays in all the inverter's operating areas throughout its entire lifecycle. Thanks to this, the probability of failure due to cosmic rays is reduced to almost zero.

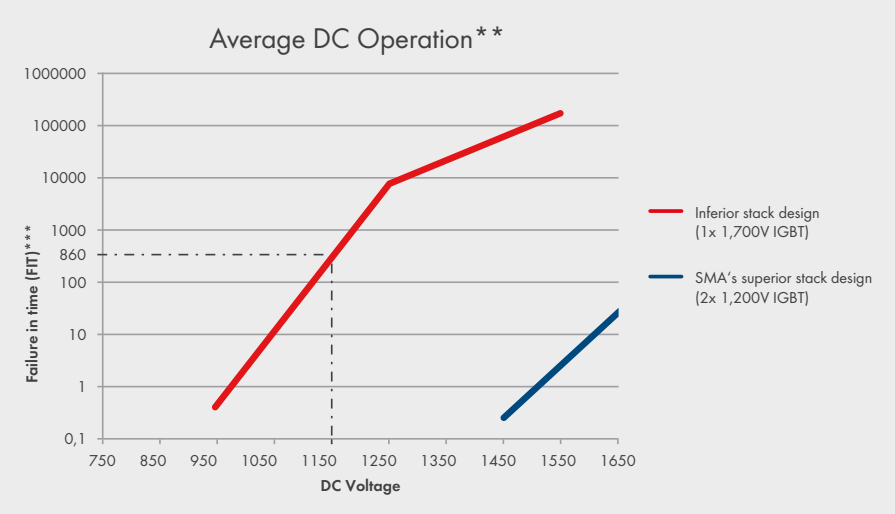
Example

Assumed average operation at 1150 V DC voltage (sea level 0)

» 1 × 1700 V IGBT = 1 inverter will fail **3 times** in 25 years*
» 2 × 1200 V IGBTs = **0 failures** in 25 years*

At 2000 m (above sea level), cosmic rays rise by at least a **factor of 5**

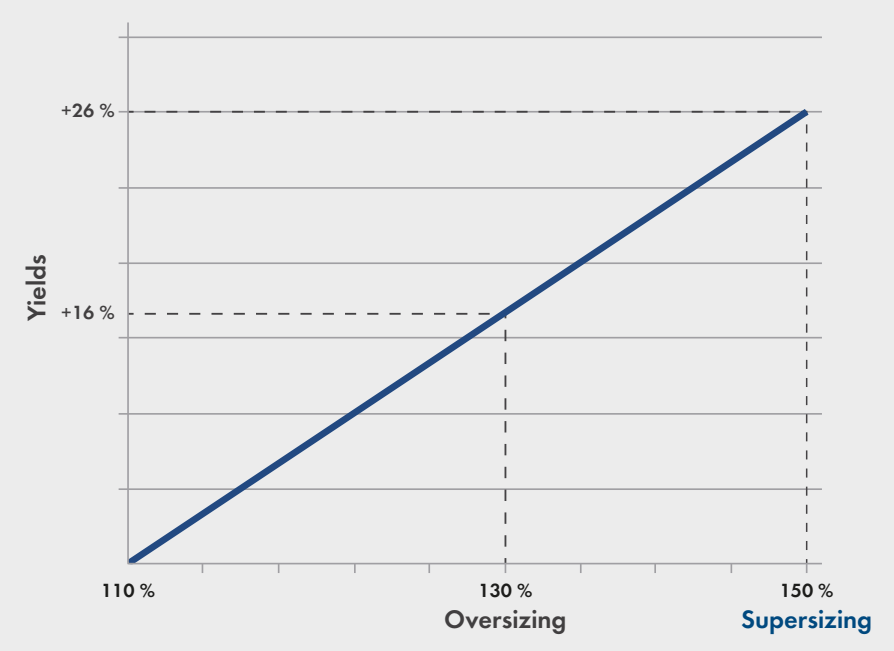
» 1 × 1700 V IGBT = 1 inverter will fail **15 times** in 25 years*
» 2 × 1200 V IGBTs = **0 failures** in 25 years*



* *Only relates to resistance to cosmic rays, resistance to cosmic rays is the effect of irradiation on elements*
** *Considering 150% PV field supersizing and curtailment*
*** *1 FIT = One failure in 1 billion operating hours*

SUPERSIZING UP TO 150% MEANS MORE THAN 25% HIGHER YIELDS

The Stack Design with a Design Reserve of 38% allows significant supersizing of the PV field of up to 150% without negative effects on the stack's service life. In this way, a constantly high energy yield throughout the entire day can be guaranteed for the complete runtime. In addition, nominal power is reached more quickly and the PV power plant has constant output power, even in strong fluctuations in irradiation. Whereas, inverters with 1700 V IGBTs only allow oversizing of the PV field of up to 110% without causing an extreme increase in the risk of inverter stack failures.



Supersizing can achieve up to 26% more energy yields.

ADDITIONAL ADVANTAGES FOR 1500 V PV PROJECTS THANKS TO MAXIMUM SYSTEM INTEGRATION

The market estimates that capital expenditure costs are reduced by up to 10% through 1500 V DC systems—in relation to the electrical balance of system (BoS) costs. Modules, module elevations and tracker systems have not been taken into consideration here.
In addition, SMA solutions offer additional cost advantages in the planning and construction phase of PV power plants. Matched components and system solutions can be transported, installed and commissioned quickly and with no extra effort. This minimizes costs and makes an important contribution in complying with schedules during the construction of PV power plants.

- Safe and easy transport in a standard container
- Low shipping costs thanks to high power density
- Ready-to-use solutions with perfectly matched components
- Quick commissioning with plug & play solutions (inverter and MVPS)

TURNKEY SOLUTIONS

INVERTERS AND MV STATIONS

DC SYSTEM TECHNOLOGY

HIGH POTENTIAL FOR COST SAVINGS

Three questions for Andreas Tügel, Technical Product Manager in SMA's Utility business unit.

1. Why is the 1500 V technology used in PV power plants?

The main reason for using the 1500 V technology in PV power plants is to reduce system costs.

In particular, the advantage in using 1500 V technology is that more modules can be installed per string thanks to the higher DC voltage. As a result, cost savings can be achieved in the DC home runs (DC cabling to the inverters). We assume that this trend will continue at an even greater rate in the years to come and will thus become a new standard in the PV industry very quickly.

2. What special requirements must inverter technology meet?

The challenge in particular for 1500 V DC-capable inverters is to design and qualify the DC components such as DC fuses, DC switches and insulation monitoring units in an appropriate manner.

A further aspect is designing the stack correctly for decade-long operation of a PV power plant.

In the Giga PV research project, which was funded by the German Federal Ministry of Education and Research (BMBF), SMA worked closely with TÜV Rheinland and the University of Kassel to develop technological solutions with regard to costs, reliability and service life for an optimized 1500 V stack. Examining the resistance to cosmic rays was essential here.

3. How do SMA customers benefit from using 1500 V inverters and system technology?

PV power plants equipped with 1500 V inverters and system technology from SMA offer maximum availability, long, uninterrupted runtimes and thus secure, reliable energy yields, long term. The possibility of supersizing and the stack topology designed for durability and freedom from faults make this a safe investment. SMA offers a complete product portfolio for the new generation of 1500 V PV power plants so that customers can obtain solutions from a single source. As a global market leader, SMA has over 30 years of experience, with over 24 gigawatts of Sunny Central central inverters have already been installed worldwide.

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