SIPREC I

IGBT Inverter - HV Power Supply for Electrostatic Precipitator ESP

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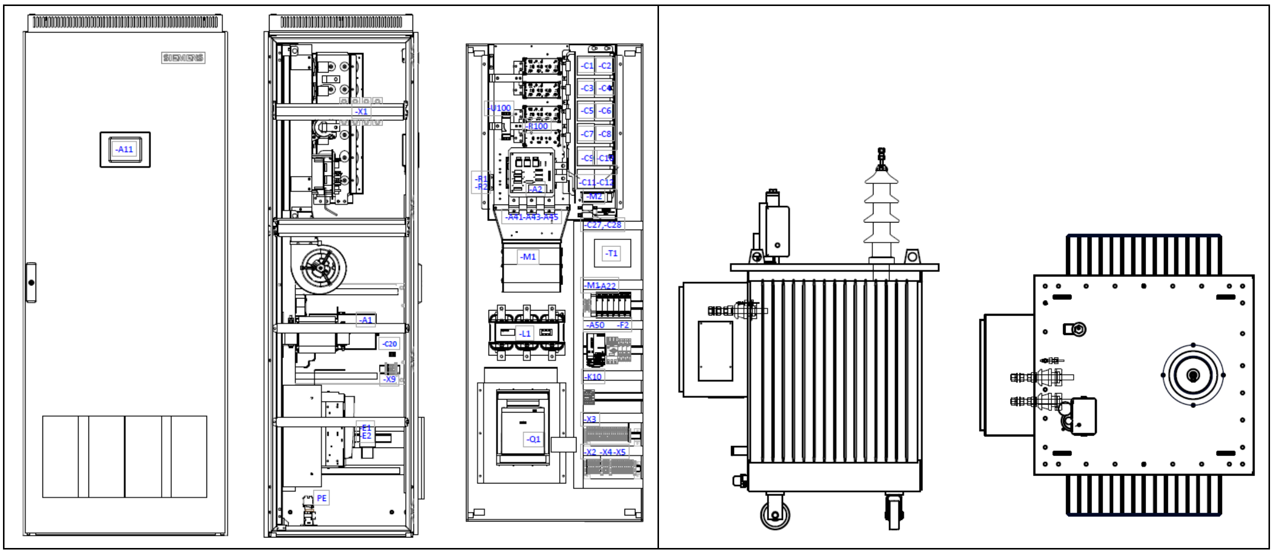
SIPREC I Power Supply

The SIPREC I technology is the 4th generation of Siemens inverter technology for ESPs high voltage power supply. The SIPREC I further development comes with:

- Modern IGBT power semiconductors (Insulated Gate Bipolar Transistors)
- PIC167 new generation of fully digital microcontroller unit
- with high-speed data processing and multitasking properties
- SITOUCH color operating touch panel
- Cubicle arrangement for easy access to all components
- Optical interface for signal exchange with high voltage transformer rectifier set (TR set) and PROFIBUS networking to prevent possible electrical interferences
- SIPREC TR500 high voltage transformer rectifier set

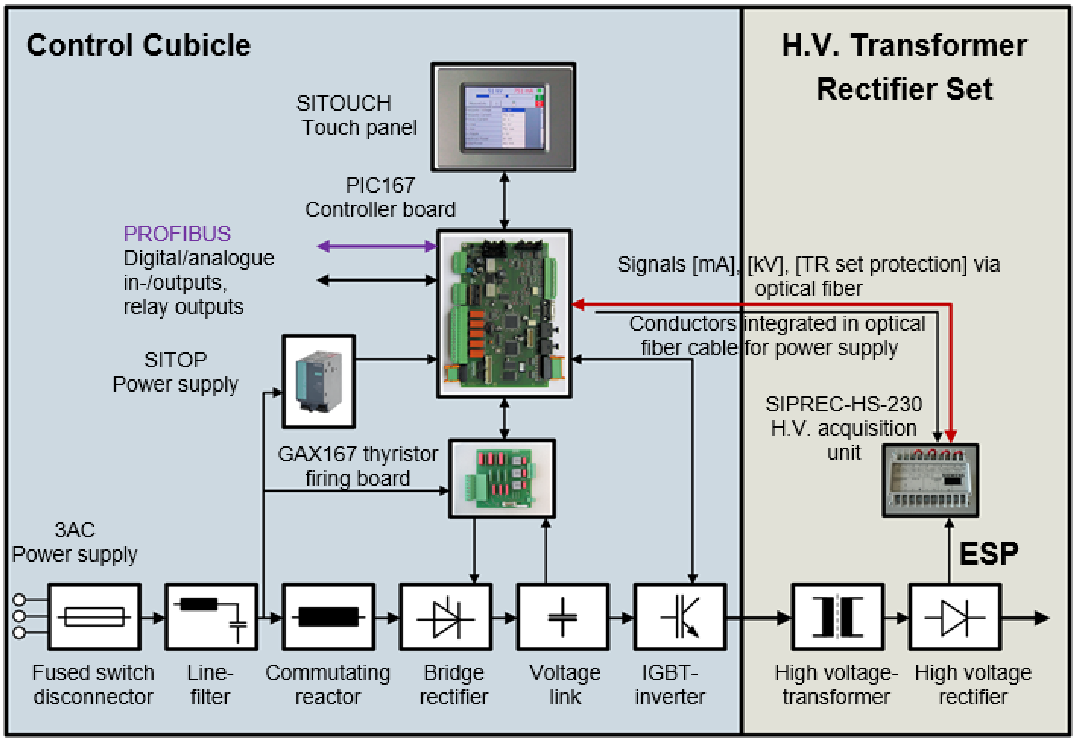


For new ESP installations we recommend installing the SIPREC I power supply system consisting of the SIPREC I control cubicle and the SIPREC TR500 T/R set for maximum performance. For retrofitting of existing ESPs, we also offer SIPREC I Hybrid IGBT control cubicle for the reuse of existing and suitable 50Hz/60Hz T/R sets.

Advantages of SIPREC I Technology

- Highest ESP collecting efficiency due to maximum corona power especially during flashover processing
- Cost savings of new projects because of the smaller dimensional requirements of the ESP
- Boosting the collecting efficiency of existing ESPs without much more cost intensive change in the mechanical construction of the ESP
- Separation of control cubicle (switch room) and TR set (ESP roof)
- Fully hermetically sealed TR set without required forced cooling, withstanding extreme industrial ambient conditions (high humidity, temperature, dust, maritime/tropical climate etc.) and maintenance free operation
- Power factor (cos φ) near 1, no compensation required
- 3-phase mains connection with considerably lower system perturbation
- Operation in DC and pulse mode with superordinated optimization by SIPREC ODS for maximum ESP collecting efficiency at lowest power consumption

SIPREC I Technology Concept



The SIPREC I control cubicle consists of a fuse-switch-disconnector with semiconductor fuses, a line filter, the commutation reactor, a half-controlled six-pulse bridge rectifier, the voltage link capacitors, the IGBT power semiconductor modules and SIPREC controller components. The controlled rectifier charges the voltage link and is operated like an uncontrolled diode bridge when a certain link voltage

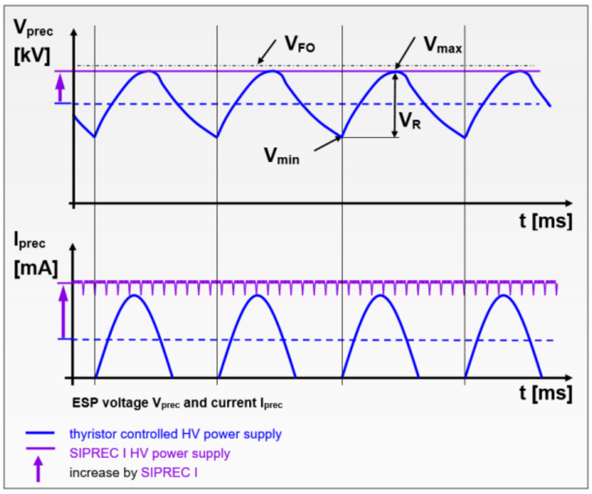
level is reached. The voltage link serves as energy storage. The IGBT inverter can either tap energy or give off energy. The inverter supplies the SIPREC TR500 transformer rectifier, accommodated in an oil-filled transformer tank, with alternating current with 500 Hz. After rectification, a DC current flows with short gaps in a 1000Hz pattern. The coordinating two-level current control operates with a frequency of approx. 10 kHz. The short switching times enable the very fast reaction to precipitator flashovers.

Type Range

Mains voltage 3AC 380-690 V	Type (mA / kV)	Power (kVA)	Cubicle size W x D x H (mm)	Cubicle weight (kg)	Transformer Rectifier set weight (kg)
70 kV	SIPREC I 2800 / 70	200	800 x 600 x 2070	300	1420
90 kV	SIPREC I 600 / 90	54	600 x 600 x 2070	270	910
	SIPREC I 1500 / 90	135	600 x 600 x 2070	280	1110
	SIPREC I 2200 / 90	200	800 x 600 x 2070	300	1110
110 kV	SIPREC I 500 / 110	55	600 x 600 x 2070	270	1160
	SIPREC I 1500 / 110	165	800 x 600 x 2070	300	1280
	SIPREC I 1800 / 110	200	800 x 600 x 2070	300	1480

Increased Corona Power

Corona power is the product from the arithmetic mean value of ESP voltage and current ($P_{corona} = V_{prec} \times I_{prec}$).

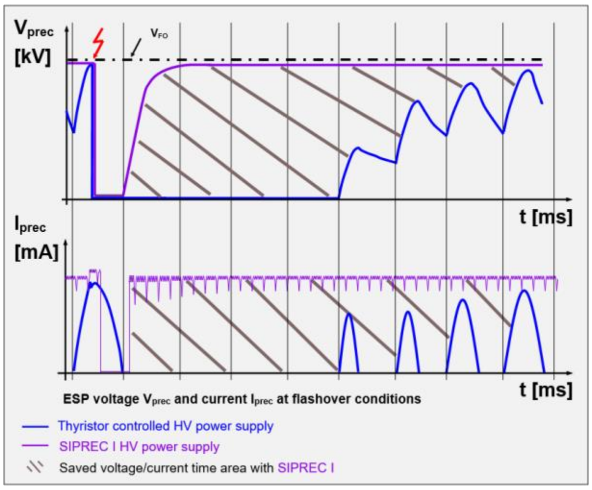


To achieve the highest possible ESP collecting efficiency, the corona power supplied must be as high as possible (@ no back corona conditions). One phase (W1C) or three phase (W3C) thyristor-controlled T/R sets cause a ripple of the ESP voltage ($V_R = V_{max} - V_{min}$) and non-continuous DC current based on the circuit concept. The voltage ripple value, depending in addition on the thyristor control angle, is typically in the range of ⅓ – ⅔ of V_{max}. The arithmetic average values for ESP voltage and current are therefore much less than the peak values.

Due to the very fast SIPREC I IGBT switching time (10 µsec) and inverting frequency of 500Hz, the SIPREC TR500 output voltage is nearly ripple-free in any working point at every output current.

As a matter of this, the mean value for ESP voltage and current is increased up to the peak values. As a result of this depending on the V / I characteristic, the corona power supplied by SIPREC I can be more than doubled compared to thyristor-controlled T/R sets.

The ESP voltage and therefore the ESP current is limited when reaching the flashover limit value V_{FO} due to the appearance of electrical discharges (flashover, spark).



Flashover / sparks must be detected immediately and the short-circuit currents feeding the arc must be stopped as quick as possible to keep the ESP voltage and current values or to enable the fast recovery.

Based on the very short SIPREC I IGBT switching times, these short-circuit currents are switched-off within some µsec only exactly when necessary, which is much faster compared to the thyristor technology.

Therefore, the required de-ionization time for non-self-quenching flashover is much lower, and the ESP voltage / current values are recovered within some milliseconds only. Detected self-quenching flashover (sparks) are processed without any de-ionization time.

This leads to remarkable increased ESP collecting efficiency during flashover processing typical for all ESP gas inlet fields.

Partial discharges typical for wet ESP's are difficult to detect by common detection methods. Not detected discharges however lead to damages on the ESP electrode system, ESP casing or insulators. SIPREC I provide in addition to the common flashover / spark detection a special detection for partial discharges to prevent the formation of arcs and to protect the wet ESP.

Optimum Operating Point with Fuzzy Logic

The ESP voltage V_{prec} must be adapted continuously to the flashover limit V_{FO}.

V_{FO} varies depending on actual operating conditions (dust concentration / composition, gas humidity, gas temperature etc.).

Fuzzy logic adapts the behavior of the power supply to the best possible operating point and the fast power electronics carries out the commands of the overlaid control even faster than the reaction time of the precipitator.

Collecting Electrode Rapping

Besides voltage supply, the effectiveness of collecting electrode rapping is of key importance to achieve best possible dry ESP collection efficiency.

To ensure effective collecting electrode rapping, the rapping intervals must be individually optimized for each electric field to suit the respective operating conditions.

In applications involving highly resistive dust or dust with a pronounced sticking behavior, the precipitator voltage may have to be reduced or even cyclically blocked during electrode rapping.

The collecting electrode rapping can be controlled by SIPREC I or the rapping signal of the external control (PLC / DCS) can be connected to SIPREC I.

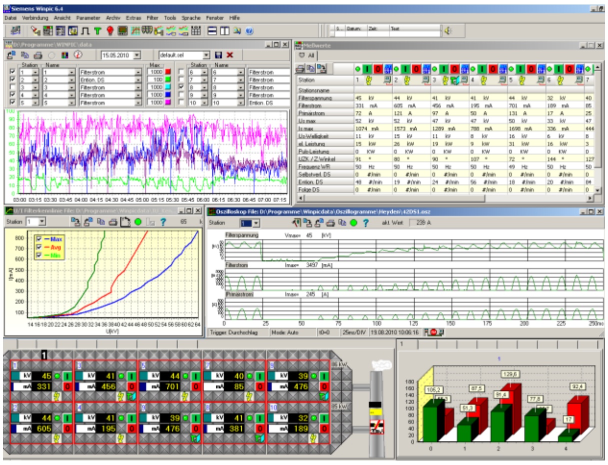
The SIPREC I controller provide 10 selectable rapping parameter sets which are adjusted and activated in accordance with the respective process conditions (e.g. rapping mode, interval settings, rapping current decrease, power-off cycle).

The coordination of the rapping intervals in the individual electric fields is accomplished with the aid of the SIPREC ODS system.

Addon: SIPREC ODS

The SIPREC ODS program based on WINDOWS operating system supports the SIPREC HV power supply systems for central operation, visualization, data archiving of measured operating values, for optimization of the ESP operation and diagnostic purposes.

SIPREC ODS optimize the ESP collecting efficiency at lowest power consumption. The extensive diagnostic functions enable beside the fault analysis the evaluation of the ESP operating process and provide information for the predictive maintenance. Furthermore, the diagnostic functions also form the basis for the fast and inexpensive Siemens Energy remote service.



For further information please see our separate SIPREC ODS brochure.

Take advantage from our experience

We are looking forward answering your questions concerning the modernization of ESP high voltage power supplies, the data exchange to the PLC / DCS, the possible increase in ESP collecting efficiency, potential for power savings or other questions related to the ESP operation.

Just get in contact with us.

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