

**ROHDE & SCHWARZ**

Make ideas real



**R & S<sup>®</sup> ESSENTIALS**

# FUNDAMENTALS OF DC POWER SUPPLIES

Interfaces, safety and arbitrary functions

Flyer | Version 01.00



# CONTROL INTERFACES



The growth in productivity has led to a dramatic improvement in the quality of our lives over the last few decades. Being able to produce more with fewer resources in a shorter amount of time makes our labor more valuable and the product of our labor cheaper. One of the factors contributing to the growth in productivity is automation.

Automation in the test and measurement industry has become widely used. Nowadays practically every modern measurement instrument can be controlled remotely. Rohde&Schwarz invests significant resources to provide its instruments with a wide variety of high-performance connectivity options.

## Main advantages of automating measurement tasks

Advantage	Explanation
Automation saves time.	Investing time into developing a remote-control application pays off:  Repeating a measurement task many times over takes significantly less time.  Automation saves you a lot of routine work and lets you focus on the creative aspects of your project.
Instruments can be operated from a distance.	This facilitates, for example, testing a device under test (DUT) in a climatic chamber or an anechoic RF chamber.
Measurements are repeatable.	Measurement tasks are always performed according to a defined procedure. Once correctly debugged, they always deliver repeatable results. This helps to increase measurement confidence.
Automated systems are easier to expand.	With an appropriate test configuration, you can perform the same measurement on several DUTs. For example, a four-channel power supply can be used to test four DUTs. If you need to connect more DUTs, you can use an automated switching unit.
Test result documentation is provided as a standard functionality.	Many programming environments offer ready-to-use toolboxes for documenting and processing test results.

# FULL CONNECTIVITY

Rohde&Schwarz power supplies offer a variety of interfaces to remotely control the instruments and to connect external devices to meet the requirements of varying test environments. Power supplies can be configured with appropriate hardware interfaces like GPIB, USB and LAN for remote control while the digital I/O interface can be used to set up trigger systems. Some power supplies can be equipped with an analog input for amplifying the power of the input signal or tracking an analog input voltage.

Depending on the power supply model, different types of interfaces are available (see table below).

# REMOTE CONTROL INTERFACES AND PROTOCOLS

Diverse remote control interfaces are available. Communication over these interfaces takes place using the SCPI command set and syntax. A USB interface is provided as standard; the LAN interface comes standard or optional. An IEEE-488 (GPIB) interface is optionally available on some instruments and can be retrofitted at a later date. All power supply parameters as well as available measurements can be remotely controlled via these interfaces.

The USB virtual COM port (VCP) lets the interface be addressed like a legacy RS-232 port. The USB communications device class (CDC) can be used to transmit Ethernet frames via USB. The USB test and measurement class (TMC) allows higher data rates, which is particularly useful when transferring files and data generated with the FastLog function provided on some of the power supplies.

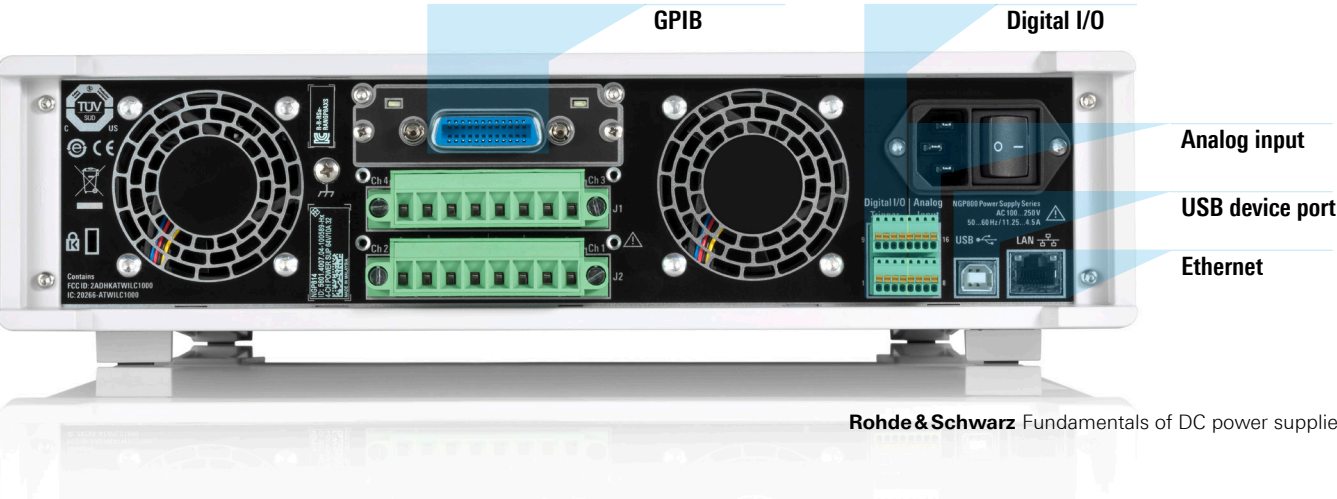
For the LAN interface (Ethernet), an IP network address can be set manually (fixed address), or a dynamic IP address can be allocated via DHCP. Some instruments can be controlled via a web interface from a browser.

Interfaces on Rohde&Schwarz DC power supplies

Interfaces	Power supplies (R&S®)								
	NGE100B	HMC804x	NGA100	HMP2000	HMP4000	NGP800	NGL200	NGM200	NGU201/401
USB	•	•	•	•	•	•	•	•	•
USB TMC	•	•	•			•	•	•	•
USB VCP				•	•				
USB CDC	•	•	•			•	•	•	•
LAN	○	•	•	○	○	•	•	•	•
GPIB		○		○	○	○	○	○	○
RS-232				○	○				
Digital trigger I/O	○	•	○			○	○	○	○
Analog input						○			
Modulation input									•

• Included      ○ Optional

Rear view of an R&S®NGP800 power supply with interface ports



# INSTRUMENT DRIVERS

Measurement instruments can be remotely controlled without the use of instrument drivers, using SCPI commands instead.

Nevertheless, for most of the Rohde&Schwarz power supplies, a comprehensive selection of drivers is available for download from our web page. Drivers make it possible to integrate remote control functionality with software tools like LabVIEW and programming languages like C, C++, Python and .NET languages in a much more efficient and reliable manner. Drivers provide procedures to encapsulate remote control functionality for certain tasks like setting parameters, starting measurements and querying results. The autocomplete function of integrated development environments (IDE) like Microsoft Visual Studio® shows available procedures and function calls together with the associated parameters and their variables, which considerably speeds up the coding process.

Virtual instrument software architecture (VISA) is required as an intermediate software layer between the instrument drivers and the drivers for the physical remote control interfaces. VISA is an application programming interface (API) that allows writing remote control code independent of the remote control interface. The instrument to be controlled and the interface for the connection are selected during runtime. In addition, VISA provides utilities like a search on the interfaces for connected instruments. VISA can be downloaded from the Rohde&Schwarz web page.

# DIGITAL TRIGGER I/O

Digital trigger I/O interfaces are available for a number of power supplies (see table on page 3). They can be individually used as trigger inputs or outputs. For easier access, the R&S®NGP800, R&S®NGL200, R&S®NGM200, R&S®NGU201 and R&S®NGU401 power supplies come with pluggable 8-pin terminal blocks for the rear output connections and analog input connections, and with a 5-pin, 8-pin or 15-pin connector for the digital trigger I/O.

The R&S®NGx-K103 option allows setting up a trigger system to generate trigger events for output control or event/status/mode indication. As an input, the trigger I/O can enable or inhibit outputs or start functions such as QuickArb or logging. As an output, the trigger I/O can indicate protection triggers in response to an overload condition, as well as voltage/current/power level events and actual output operating modes. In addition, the digital trigger system allows you to control output delays or fuse linking across multiple channels or instruments.

# REMOTE CONTROL VIA VNC

The R&S®NGP800, R&S®NGU, R&S®NGL200 and R&S®NGM200 power supplies offer the possibility of being controlled via virtual network computing (VNC). With this technology, not only the power supply's graphical user interface is displayed on a remote device (e.g. a PC or mobile device), but also all controls such as buttons and rotary knobs otherwise available for direct control. The power supply can thus be operated from a remote device without having physical access to it. To establish a VNC connection, the power supply must be available in the same network and accessible via LAN. After VNC has been activated on the power supply, it can be remotely accessed via its IP address. There are two ways to access the instrument. Either, a VNC client on the remote device can be used. Or, a web server based VNC client enables real-time user interaction with the power supply without the necessity of installing a VNC client. The latter application can be accessed by entering the power supply's IP address in the URL bar of the browser.



Remote control of an R&S®NGP800 power supply via VNC.

## Drivers for Rohde & Schwarz DC power supplies

Drivers	Power supplies (R&S®)								
	NGE100B	HMC804x	NGA100	HMP2000	HMP4000	NGP800	NGL200	NGM200	NGU201/401
IVI driver	•	•	•	•	•	•	•	•	•
VXI plug & play driver	•	•	•	•	•	•	•	•	•
LabVIEW driver	•	•	•	•	•	•	•	•	•
LabWindows/CVI, Linux/Mac OS X driver	•	•	•	•	•	•	•	•	•
USB VCP driver				•	•				
USB CDC driver	•	•	•						



# ANALOG INTERFACES



## ANALOG INPUT

The R&S®NGP-K107 analog input option for the R&S®NGP800 power supplies makes it possible to control output voltages and currents directly and much faster. An external control voltage from 0 V to 5 V can control any or all of the outputs with an input scaling from 0% to 100%. Galvanic isolation between the control voltage and the outputs greatly simplifies the connection while maintaining user safety even for high-voltage and floating-circuit applications. The analog input can be used, for example, to quickly and simultaneously change the output voltage on a number of power supplies connected in series or in parallel.

The analog input can be deployed to make the output voltage slowly follow an analog input voltage. With an update rate of 1 kHz, however, this process is not fast enough to be used for modulation.

## MODULATION INPUT

The modulation input on the R&S®NGU401 source measure unit allows an AC signal with up to 1 kHz bandwidth to be modulated on the set DC voltage. A possible application is measuring the power supply rejection ratio on amplifiers.

### Properties of the R&S®NGU401 modulation input

Property	R&S®NGU401
Modulation bandwidth	DC to 1 kHz
Input level	-24 V to + 24 V
Accuracy (displayed modulation value)	< 0.02 % + 2 mV

# SAFETY



## PROTECTION FUNCTIONS TO SAFEGUARD THE INSTRUMENT AND DUT

Power supplies with DUT protection are recommended if there is a risk of damage to the DUT (load) caused by over-voltage or overcurrent. On many power supplies, there is a limit defining the maximum settable voltage and current. When such a limit has been set, the power supply will not exceed the specified voltage and/or current regardless of the load.

Since even the most experienced user is occasionally distracted, the output channels are protected against overload and short circuits so that the power supply will not suffer damage. You can set the maximum current, voltage and power separately for each channel. If a preset limit is reached, the affected output channel will be automatically switched off. You are also alerted by a beeping sound and the corresponding icon flashing in the status bar.

Rohde & Schwarz power supplies incorporate a number of protection functions to make sure the DUT and the instrument will not be damaged in the event of a fault. Depending on the power supply model, users can separately configure the following for each channel:

- ▶ Maximum current (overcurrent protection, OCP)
- ▶ Tracking and link functions (FuseLink)
- ▶ Fuse delay
- ▶ Maximum voltage (overvoltage protection, OVP)
- ▶ Maximum power (overpower protection, OPP)
- ▶ Maximum temperature (overtemperature protection, OTP)

### Overcurrent protection (OCP)

To protect sensitive loads, the power supply channels are equipped with electronic fuses that can be set individually for each channel. If the current in a specific channel exceeds the set maximum value, the channel is automatically switched off and the overcurrent symbol flashes. Adjust the delay (sensitivity) and the switch-on response time of the electronic fuses as required for your application.

### Tracking and link functions

When using your instrument to supply bipolar circuits, for example, a convenient tracking function lets you vary the voltage on all channels in parallel. The FuseLink function for overcurrent protection allows you to link fuses across multiple channels. It can be configured to switch off all channels when one of the channels reaches its limit value. It can also be configured so that certain channels remain active, for example to power the fan that cools the DUT.

### Fuse delay

The Rohde&Schwarz power supplies come with electronic fuses whose delay can be adjusted individually for each channel. By controlling the delay, i.e. the time after which a fuse trips in response to a given event, users can control the behavior of their power supplies to prevent premature switch-off of a channel due to a short current spike during operation (see figure below).

### Overvoltage protection (OVP)

If the output voltage on a specific channel exceeds the configured maximum value, the channel is switched off and the corresponding OVP indicator flashes on the display. Depending on the setting, either the voltage configured on the instrument or the voltage measured by the instrument is used as the OVP switch-off threshold.

### Overpower protection (OPP)

Instead of the maximum voltage, the maximum power can be set and used as the switch-off threshold.

### Overtemperature protection (OTP)

The Rohde&Schwarz power supplies have internal over-temperature protection that switches off the affected channel if a thermal overload is imminent.

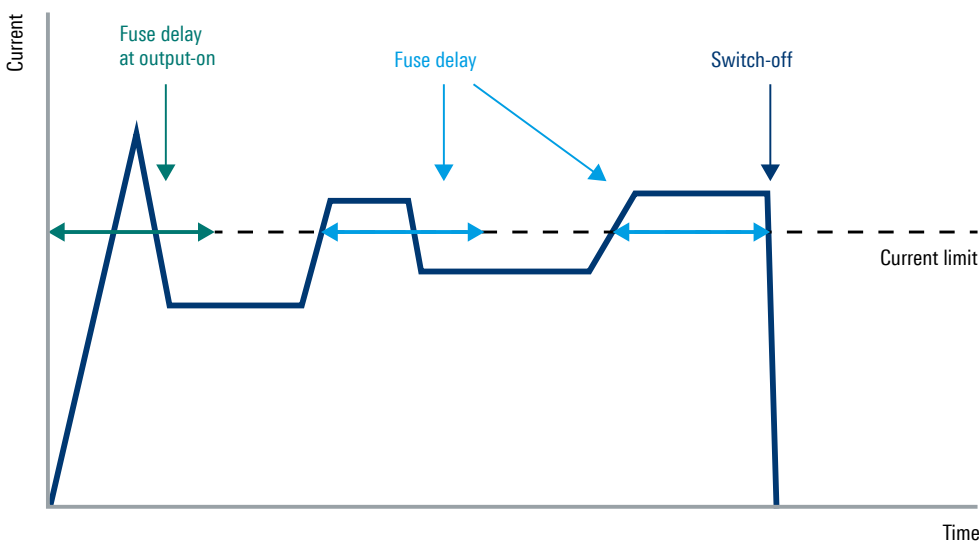
### Safe and quiet working environment

To reduce noise to a minimum, the Rohde&Schwarz power supplies automatically adjust the fan speed to the load condition, allowing you to work in a quiet environment.

All Rohde&Schwarz power supplies include sockets for 4 mm safety-type banana plugs, as required by an increasing number of laboratories for safety reasons.

## Configuring fuse delay on Rohde&Schwarz DC power supplies

"Fuse Delay At Output-On" specifies how long a fuse should remain inactive after a channel is switched on. The sensitivity of the fuse is specified by "Fuse Delay Time".

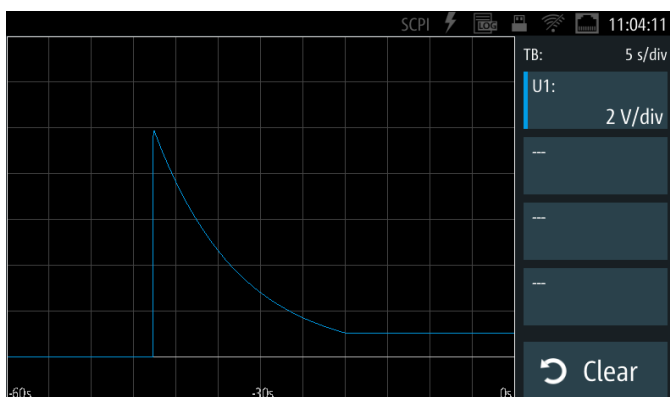


# ARBITRARY AND RAMP FUNCTIONS

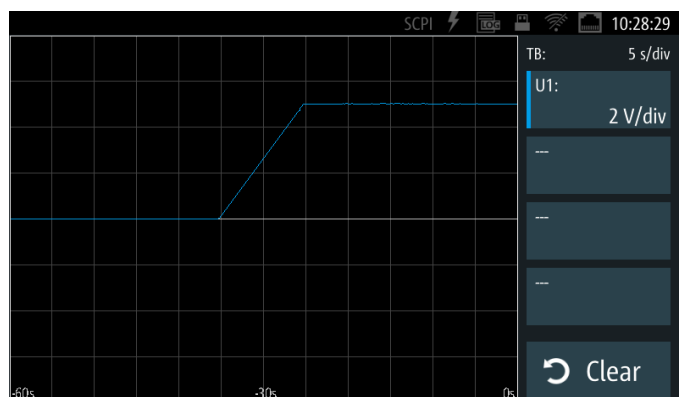


An arbitrary file stores voltage, current and dwell time for a certain number of points. In addition, the number of repetitions for a defined sequence of points can be specified. This allows, for example, to emulate real-world scenarios using arbitrary functions as voltage or current inputs for testing the resilience of a DUT against variations in supply voltage and current delivery.

Unlike the arbitrary function, the curve of the ramp function has a fixed shape. The ramp functionality provides a linear “fade-in” curve for the unloaded voltage versus time after switching on the corresponding output channel of the power supply. It can be used to protect circuits from damage by inrush current. The only configurable parameter for the ramp function is the ramp time from switch-on until the full unloaded voltage is reached.



Example of an arbitrary function.



Example of a ramp function.



# ARBITRARY AND RAMP FUNCTIONS WITH ROHDE & SCHWARZ DC POWER SUPPLIES

DC power supplies from Rohde & Schwarz provide arbitrary functions like EasyArb or QuickArb, and in some cases a somewhat simpler variant of EasyArb (see table on page 10). The parameters for the individual channels are organized according to a defined scheme, providing a certain degree of compatibility between arbitrary files.

The following sections highlight the properties of the EasyArb and QuickArb functions.

## Properties of EasyArb function

Property	Range
Parameters	voltage, current, dwell time
Maximum number of points	128 or 512 (depending on model)
Dwell time	10 ms to 600 s (10 ms increments)
Repetitions	continuous or burst mode with 1 to 255 repetitions
Trigger (optional)	manual, remote, or via optional digital trigger input
Trigger function	start

## Properties of QuickArb function

In addition to larger parameter ranges and a higher number of points, the QuickArb function supports subgroups, specification of the end behavior, and linear ramp-shaped interpolation between points. Another advantage is the higher time resolution of 1 ms for both the minimum dwell time and the increments for advancing to the next point.

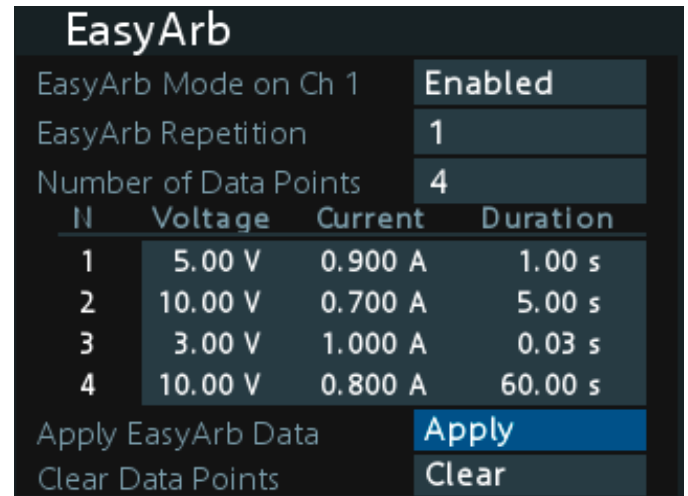
Property	Range
Parameters	voltage, current, dwell time, interpolate
Maximum number of points	1024, 2048 or 4096 (depending on model)
Maximum number of subgroups	0 or 8 (depending on model)
Dwell time	0.1 ms to 20 h (depending on model)
Repetitions	continuous or burst mode with 1 to 65535 repetitions
End behavior	hold or output off
Trigger (optional)	manual, remote, or via optional digital trigger input
Trigger functions	start and/or step

With the QuickArb functionality, not only the start of the arbitrary function can be triggered, but also the advancement of a sequence to the next point. This feature is useful, for example, for synchronizing DC voltage sweeps with procedures that take place on measurement equipment.

## Arbitrary editor

Rohde & Schwarz DC power supplies offer an editor for modifying arbitrary curve shapes on the touchscreen.

The unloaded voltage, current limit and dwell time can be edited for every point in the curve. Additional parameters like the number of repetitions can also be modified.



Arbitrary editor on the R&S®NGE100 power supplies.



Arbitrary editor on the R&S®NGM200 power supplies.

With the QuickArb editor, arbitrary curves can be stored to and loaded from ASCII files with character-separated values (CSV). With the EasyArb function, arbitrary curves are stored together with the global instrument settings.

Arbitrary curves can also be loaded into the DC power supply via remote control, for example using the R&S®HMEexplorer software.

	A	B	C	D
1	Column1	Column2	Column3	Column4
2	#Device	NGM202		
3	#Device Name			
4	#Format	ARB		
5	#Date			
6	#Rep	1		
7	#EP	24		
8	#Version			
9	#Serial No.			
10	#EndBehavior	Hold		
11	Voltage	Current	Time	Interp
12	10.000000	0.010000	1.000000	true
13	9.048000	0.009048	1.000000	true
14	8.187000	0.008187	1.000000	true
15	7.408000	0.007408	1.000000	true
16	6.703000	0.006703	1.000000	true
17	6.065000	0.006065	1.000000	true

Example of an ASCII CSV file stored from the QuickArb editor.

## EasyRamp

The ramp time can be selected between 10 ms and 10 s in 10 ms increments.

## Arbitrary function overview

The table below shows the arbitrary functions supported by Rohde&Schwarz DC power supplies.

The arbitrary function on the R&S®HMP2000 and R&S®HMP4000 is similar to EasyArb, with a maximum dwell time of 60 s.

## Arbitrary functions supported by Rohde & Schwarz DC power supplies

Arbitrary functions	Power supplies (R&S®)								
	NGE100B	HMC804x	NGA100	HMP2000	HMP4000	NGP800	NGL200	NGM200	NGU201/401
EasyArb	•	•	•						
QuickArb						•	•	•	•
Other arbitrary function				•	•				
EasyRamp	•	•	•			•	•	•	•

# CAN I USE THE ARB FUNCTIONALITY ON A DC POWER SUPPLY INSTEAD OF AN ARBITRARY FUNCTION GENERATOR AND VICE VERSA?

This highly depends on the application. The table below can serve as a decision-making aid.

## Comparison of arbitrary functionality properties of a DC power supply and an arbitrary function generator

Property	Arbitrary functionality on a DC power supply	Arbitrary function generator, e.g. R&S®HMF2550
Sample rate	1 ksample/s	up to 250 Msample/s
Bandwidth	approx. 500 Hz	up to 50 MHz
Curve length	up to 4096 points	number of points in the million range
Bipolar output (negative output voltage possible)	requires four-quadrant power supply	yes
Output power	up to 160 W	up to 0.5 W (10 V (peak) into 50 Ω)
Signal purity	not specified	THD < 0.04% up to 100 kHz

# PRECISION MADE EASY



## R&S® ESSENTIALS

Developers and engineers worldwide have been relying on the T&M expertise of Rohde & Schwarz for more than 80 years. The company is known for providing innovative performance testing solutions and applies its expertise and high quality standards to its portfolio of essential bench instruments – the R&S® Essentials. Rohde & Schwarz is building this industry-defining portfolio, ranging from oscilloscopes, DC power supplies and signal generators to spectrum analyzers, vector network analyzers, meters and counters, with the strategic goal of becoming a full portfolio supplier in the T&M market. For R&S® Essentials, Rohde & Schwarz is extending its reach through a distribution network with channel partners worldwide, offering a one-stop shop experience for any type of T&M task, application and budget. Whether in the lab or field, on campus or in a production facility, R&S® Essentials demonstrate that high-quality hardware and software solutions do not have to come with a high price tag.

## Service that adds value

- ▶ Worldwide
- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

## Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

[www.rohde-schwarz.com](http://www.rohde-schwarz.com)

## Sustainable product design

- ▶ Environmental compatibility and eco-footprint
- ▶ Energy efficiency and low emissions
- ▶ Longevity and optimized total cost of ownership

Certified Quality Management

**ISO 9001**

Certified Environmental Management

**ISO 14001**

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