

plasmabrush[®]

Operating Instructions

Plasma generator PG31



We are pleased that you decided on a brand device from **relyon plasma** GmbH and thank you for the trust you have placed in our company. In order to make the best possible use of the device, please read through these Operating Instructions carefully.

i **Important advice!**
It is essential to read these Operating Instructions thoroughly prior to assembly, installation and commissioning.

It is essential to observe the safety instructions! Nonobservance of the safety instructions can result in accidents and cause serious injury and damage to property.

Commissioning and operation of the plasma generator must only be carried out by qualified and instructed technicians!

Provide instruction for your personnel. The operating company/user is responsible for ensuring that personnel fully comprehend how to operate the device and understand the safety regulations.

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1 Safety

The plasma generator has been built in accordance with the relevant international standards. As with every technical product, however, the system may be dangerous in the case of unauthorized or non-specified use.

In addition to the notes in these Operating Instructions, observe generally applicable safety instructions.

Work with the plasma generator can be dangerous and result in serious - in some cases even fatal - injuries. Therefore always protect yourself and others.



Caution – Danger!

Please mind and follow the safety advices and demands of this operation instructions, otherwise serious – in some cases even fatal – injuries may result of the use of this device.

1.1 Residual dangers

This device has been produced with state-of-the-art technology. Nevertheless, residual risk can never be totally excluded.

It is essential to observe the following safety instructions:



Caution – electrical voltage!

- Danger from high voltage
 - Never place your hands in the plasma jet.
 - Never touch the plasma generator during operation.
 - Never direct the plasma jet at persons or animals.
- Danger from 230 V. If damage is detected at the electrical connection, mains cable or at the device:
 - Do not put the device into operation.
 - Have the damaged parts repaired by a specialist or replace them.



Caution – health hazard!

The device operates at a high frequency (~ 50 to 60 kHz at the plasma generator).

- Persons with a pacemaker or hearing aid should take the following precautionary measures:
 - Never hold the plasma generator near a pacemaker or hearing aid.
 - Consult a doctor prior to working near the plasma generator.
- In hospitals or similar buildings, it is possible that operation of the system may impair the operation of electromedical, information technology and other devices (ECG, PC, ...).
 - Prior to commissioning the device, ensure that the users of such devices or systems have been informed of this possibility.



Caution – hot surface!

Temperatures of up to 200 °C are possible at the housing of the plasma generator.

- Wear protective gloves when handling the device.
- Wait until the device has cooled down.

**Caution – nitrogen oxide and ozone (O₃)!**

Ozone quantities and nitrogen oxides can be created at the device that are outside the currently applicable limit values.

- During operation, always stay at least 1 m away from the plasma generator.
- Ensure that the work area is well ventilated.
- Install an exhaust system.

**Risk of stumbling!**

Lay cable and gas line in suitable cable routes. Lay the cable so that there is no danger of stumbling.

**Caution – UV/VIS light!**

UV/VIS light is discharged at the device.

- Always stay at least 1 m away from the plasma generator.
- Use suitable UV eye preservers if you have to look at the plasma flame for long periods.
- Use a protective window (filter strength min. 2), if people work longer in the vicinity of the plasma generator
- Attach warning sign W09 "Warning of optical radiation"

**Caution – gas bottles! Risk of explosion!**

Gas bottles are highly pressurized and are a source of danger.

- Information on the correct handling of gas bottles is available from your gas supplier.
- Protect the bottles against direct solar radiation, open flame and high fluctuations in temperature (e.g. very low temperature).
- Ensure that the gas containers are in impeccable condition.
- Only use certified parts, such as tubes, couplings, pressure reducers, etc.
- Never lubricate the connections and fittings with oil or grease!

**Caution – noise!**

During operation of the plasma generator, depending on the application noise emission is generated that can cause hearing damage in the long term.

- During continuous operation, always wear adequate ear protection.
- Protect other persons working in the area.

**Caution – damage to device possible!**

The device may overheat.

- Do not cover the fan slots.

1.2 Information for the user / user obligations

- Emitted interference can always be expected at the plasma generator.
 - The system is tested in accordance with the EMC directive.
 - The user must check and ensure electromagnetic compatibility with other electric and electronic devices in the direct vicinity.
- The plasma generator must only be operated with the original plasma power supply and the original cable extension from **relyon plasma** GmbH.
- Ensure that:
 - The operating personnel have read and understood these Operating Instructions.
 - Persons near the plasma jet have also been informed of the hazards and have the necessary protective equipment.
 - Maintenance work is only carried out by qualified technicians.
- Provide instruction for operating personnel, in particular, on the safety instructions in these Operating Instructions.
- Always keep the system in perfect working order.
- Modifications to the device shall result in forfeiture of the operating license (US) and invalidation of the guarantee. Exception: The modifications are expressly permitted by the manufacturer.

1.3 Specified operation

The plasma generator is designed exclusively for plasma treatment of material surfaces (metals, textiles, glass, plastics) for activation, cleaning, coating or residue removal at atmospheric pressure.

Under no circumstances may the device be operated by untrained personnel.

1.4 Impermissible operating conditions

Device operation is impermissible under the following conditions:

- Use in potentially explosive areas (EX).
- strong dust deposition
- too high air humidity (see technical data, page 9)
- an installation location with an absolute altitude higher than 1.000 m
- strong vibrations

1.5 Emissions

The following emissions are discharged from the device:

- Small quantities of UV light.
- Small quantities of ozone (O₃) and nitrogen oxides (NO_x). The relevant limit values (MAK, TRK, BAT) may be exceeded.

Plasmagas	Gasflow	Ozone	NO _x
Air	35 Nl/m	1,5 mg/m ³	3500 mg/m ³
Nitrogen	35 Nl/m	0,4 mg/m ³	350 mg/m ³



Note!

As a precautionary measure, an exhaust system with a delivery volume of at least 500 liters/minute is recommended.

2 Device description

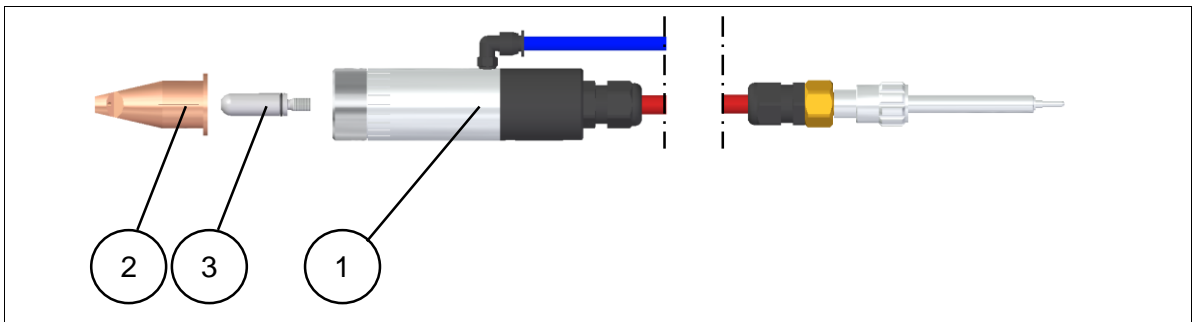
2.1 Function

The plasma generator is a part of an atmospheric pressure plasma generator used for atmospheric plasma treatment or pretreatment of a very wide variety of material surfaces. It is designed for industrial applications where, for example, surfaces are activated with plasma and cleaned prior to printing, bonding or painting. The application of surface coatings is also possible.

The device is also suitable for laboratory operation by instructed personnel.

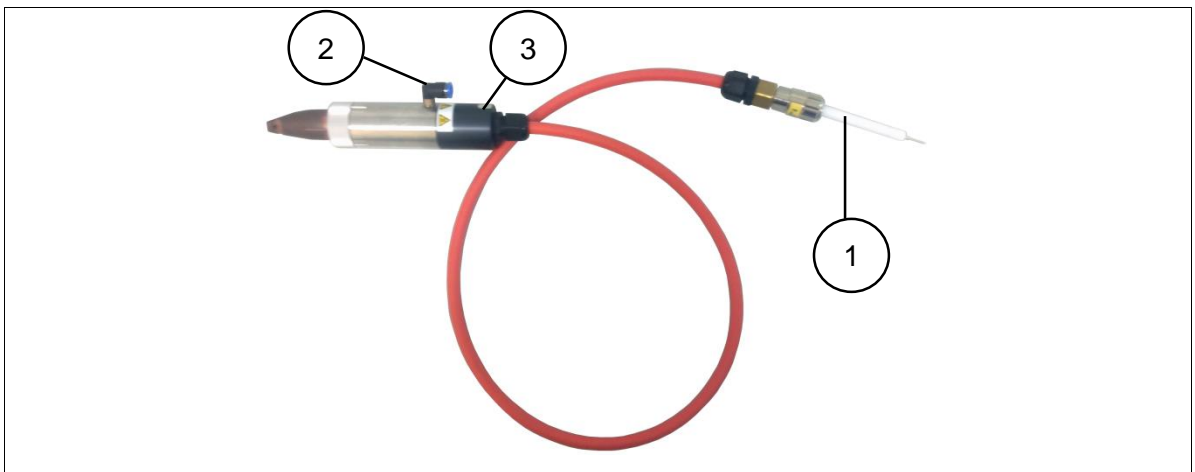
2.2 Device overview

2.2.1 Device



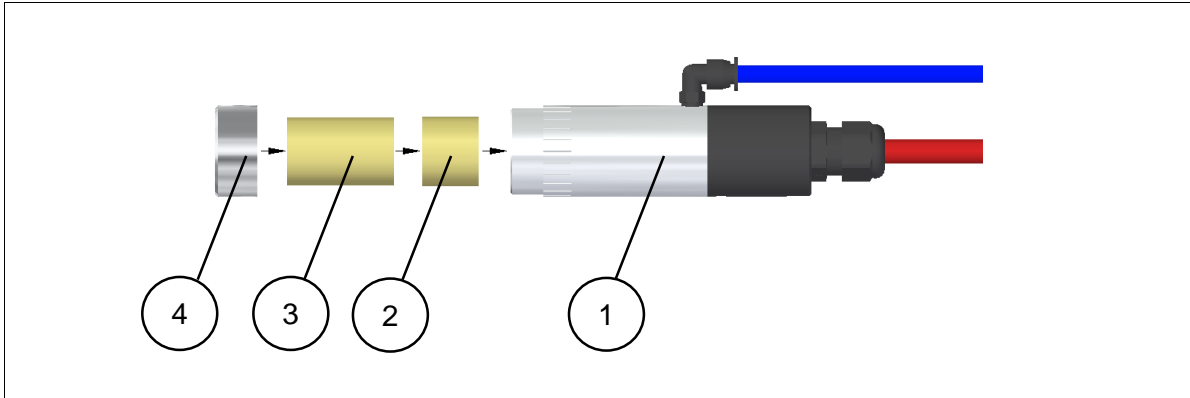
No.	Component
1	Plasma generator
2	Plasma nozzle (outer electrode) – not included – (shape may vary depending on application)
3	Plasma electrode (inner electrode)

2.2.2 Connections



No.	Component
1	High-voltage plug
2	gas connection
3	ground connection

2.2.3 Spare parts



No.	Component
1	Plasma generator
2	Ceramic spacer sleeve
3	PB3 Ceramic sleeve
4	PB3 Nut



Caution: Ceramic sleeve is in the nozzle holder!

1. Note: ceramic barriers (2 and 3) are inserted into the plasma generator (1).
2. **Ensure that the barrier sleeves (2 and 3) are inside the plasma generator (1) in correct order.** A lack of barrier sleeve (2 and 3) or incorrectly inserted barrier sleeve (2 and 3) leads to the destruction of the plasma generator.
3. The barrier sleeve (2 and 3) consists of ceramic – warning of breakage.

2.3 Scope of delivery

The following components are included in the delivery:

- plasma generator
- inner electrode (already mounted)
- operating Instructions

Not included:

- plasma nozzle (outer electrode)

3 Technical data

3.1 Technical data

Designation	Value
Working voltage of plasma generator	<ul style="list-style-type: none"> • up to 20 kV (max. voltage during ignition) • up to 2 kV (average operating voltage)
Dimensions	
<ul style="list-style-type: none"> • Plasma generator 	Mass: 0.5 kg; 1.1 lbs depending on configuration Cable length: 1.000 mm (39.4") or 2.000 mm (78.7") depending on configuration Ø Clamping area Plasmagenerator: 32mm; 1.26" Ø _{max} HV-Plug: 22mm; 0.87
<ul style="list-style-type: none"> • Minimum bending radius of HV cable 	120 mm; 4.72"
<ul style="list-style-type: none"> • Maximum torsion cable extension 	±180°/2m
Limit temperature	
<ul style="list-style-type: none"> • Plasma generator 	≤ 200 °C; 392 °F
Operating conditions	
<ul style="list-style-type: none"> • Air humidity 	< 80% rel. (non-condensing)
<ul style="list-style-type: none"> • Temperature 	10 – 40 °C; 50 – 104 °F
Storage conditions	
<ul style="list-style-type: none"> • Air humidity 	< 80% rel. (non-condensing)
<ul style="list-style-type: none"> • Temperature 	0 – 60 °C; 32 – 140 °F
Noise emission	
<ul style="list-style-type: none"> • Sound pressure level at distance of 1 meter 	> 85 dB(A) with a gas flow > 40 Nlm
Gas connection	
<ul style="list-style-type: none"> • Gas types 	Compressed air (purified, free of oil and lubricants) Nitrogen (tech. gas, free of particles and oil) Other types only by agreement with relyon plasma .
<ul style="list-style-type: none"> • Gas flow 	35 – 80 Nlm
<ul style="list-style-type: none"> • Quality 	Compressed air 1.4.1 according to ISO 8573.1 Nitrogen 2.8 (N2) according to DIN EN ISO 14175:N1
<ul style="list-style-type: none"> • Connection 	6 mm quick-action coupling

3.2 Permissible operational settings

The plasma generator system is designed for plasma treatment of material surfaces (metals, textiles, glass, plastics) for activation, cleaning, coating or residue removal at atmospheric pressure. This type of plasma treatment produces significantly improved results during subsequent gluing, painting, printing, coating, wetting, lamination, metalizing and bonding of surfaces.

All system components in the working area of the plasma generator must be grounded.

The specified limit values must always be observed during operation:

Designation	Value
Gas flow	Air: $\geq 35 - \leq 80$ Nlm Nitrogen: $\geq 35 - \leq 80$ Nlm
Working distance (plasma generator to substrate)	> 6 mm; 0.236" (on surfaces)
Safety distance (persons to plasma generator outlet opening)	1000 mm; 39.37"
On-load factor	100%
Plasma on	The compressed air supply must be switched on at least 2 seconds, before turning the high voltage for plasma generation.
Work space	All components in contact with the plasma must be fixed electrically isolating (electric strength 15 kV/mm)



Caution – electrical voltage!

- Danger from high voltage
 - During operation, never touch the substrate to be treated.



Caution – damage to device possible!

- The unit can be damaged if more than one attached cable extensions HVC is in use.
- The plasma generator must be operated only with one cable extension HVC.

3.3 Setting the gas flow volume

The required quantity of gas is 35 up to 80 Nlm and must not deviate. Deviations lead to the destruction of the plasma generator. Recommended Gas inlet pressure 5.0 bar - 8.0 bar.

4 Transport/storage

- Store the plasma generator in a dry location. This prevents the electrical contacts from corroding.
- Protect the plasma generator and the gas connection against contamination and foreign bodies.

5 Installation

5.1 Device



Caution – electrical voltage!

Danger from 230 V and high voltage.

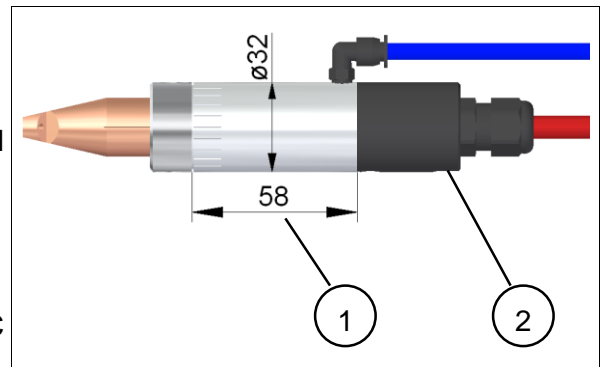
- The connection to the current supply and the connection of the plasma generator or HV cable extension to the media supply must only be made by qualified electricians.

Before installing the device, the following conditions must be met:

- A suitable gas supply must be available.
- The device must be undamaged.
- In the permanent installation or in the electrical installation of the building has to be a suitable upstream all-pole switch or circuit breaker according to the requirements of national security (Germany: VDE 0100) to disconnect the device from the supply voltage. This separating device must be located close to the device and must be easily accessible for the user. In addition, this switch has to be designated as a breaker for the device.

To install the device, carry out the following steps in the specified sequence:

1. Install the plasma generator in a suitable support.
 - The clamping force on the housing of the plasma generator must not exceed 200 N punctual.
 - The plasma generator must only be installed in the designated clamping range (1).
2. Connect the plasma generator to the HVC cable extension.



3. Make sure, the gas supply is mounted properly.
 4. Ground the plasma generator at the designated grounding point (2).
 5. Open the gas supply (customer provided).
 - The gas inlet pressure must be between 5 and 8 bar.
- ✓ The plasma generator is installed.

5.2 EMERGENCY-STOP function

The device will be integrated on site in the EMERGENCY-STOP function of the higher-order main system.

- If the device voltage supply is cut off as a result of the EMERGENCY-STOP function of the higher-order main system, the power supply and compressed air supply of the device is disconnected.
- Prior to switching on again, a safe initial state must be established by the higher-order main system.



Caution – electrical voltage!

Danger from high voltage

- It is important to ensure that both control voltage and the mains is disconnected for the device in emergency stop.

6 Operation

6.1 Switching on device



Caution – damage to device possible!

The plasma generator can be damaged if it starts up without gas.

- Never switch the plasma generator on before the gas flow is switched on (2 seconds).

To switch on, carry out the following steps in the specified sequence:

1. Ensure that the gas supply is connected and opened.
 2. Make sure that the plasma generator is connected to a suitable power supply (customer provided).
 2. Switch the device on (customer provided).
 3. Switch on the plasma generation.
- ✓ The device is switched on.

6.2 Treating surfaces



Caution – damage to device possible!

If operating conditions are not satisfied, this can result in damage to the device.

- When operating the device, the limit values specified in the technical data must be observed, see pages 9 and 10.

The effect of the treatment depends on the gas flow, default setting and working distance and varies according to process gas, treatment duration and the material being treated.

Examples of plasma treatment can be obtained directly from the **relyon plasma** GmbH.

6.3 Switching off device

**Caution – damage to device possible!**

The plasma generator can overheat if the system is switched off during the gas after-flow period.

- Never switch off the system during the gas after-flow period (2 seconds).

To switch off, carry out the following steps in the specified sequence:

1. Switch off the plasma generation (customer provided).
 2. Switch off the power supply (customer provided).
 3. Switch off the gas flow.
 4. Close the gas supply.
- ✓ The device is switched off.

7 De-commissioning

**Caution – electrical voltage!**

Danger from 230 V and high voltage.

- The disconnection of the current supply and the disconnection of the plasma generator from the media supply must only be carried out by qualified electricians.

To de-commission the device, carry out the following steps in the specified sequence:

1. Switch off the media supply.
 2. Disconnect the gas supply.
 3. Disconnect the power supply.
 4. Disassemble the plasma generator.
- ✓ The device is not in operation.

8 Maintenance



Caution – high voltage! Danger to life!

High voltage is generated in the unit of the plasma generator. It is still present after the device has been switched off.

- Opening the device is prohibited.
- Always disconnect the power supply to the device prior to care, maintenance and repair work and before opening the plasma generator.



Caution – damage to device possible!

Opening the device may result in it being damaged.

- Opening the device is prohibited.

8.1 Cleaning



Caution – hot surface!

Temperatures of up to 100 °C are possible at the housing of the plasma generator.

- Wear protective gloves when handling the device.
- Wait until the device has cooled down.



Note!

The plasma nozzle and electrode are subject to wear.

If the plasma nozzle has a thick oxide layer and the electrode has large penetration cavities, the ignition properties deteriorate and the temperature of the plasma flame increases.

Parts then have to be replaced.

Only clean the plasma generator externally.

- Only dry clean the plasma generator.
- The media supply must be switched off.
- The plasma generator must be cooled down.

8.2 Replacing electrode and nozzle

The electrode and nozzle of the plasma generator must be replaced in specific intervals depending on the application.

For changing and for the changing intervals of the electrode or nozzle, use the according Datasheet.



Note!

Depending on the application different nozzles and electrodes can be used. Please follow the instructions in the operating and maintenance instructions for each nozzles sets.



Caution – damage to device possible!

By loosening certain threaded connections the plasma generator can be destroyed.

- Please follow the instructions in the operating and maintenance instructions for each nozzles sets.
- Loosening connections other than for the change of nozzle and electrode explicitly stated is prohibited!

9 Correction of faults

9.1 No plasma formation

If the device does not create plasma, check the following items first:

- Is the current supply connected?
- Is the power supply operated correctly?

- Is the gas flow volume sufficient?
 - $\geq 35 - \leq 80$ Nl/m
- Is the HV cable and gas line undamaged?
- Is the HV cable and gas line kinked?

9.2 Operation malfunctions

- Plasma ceases during operation.
- Parasitic discharges (discharges at undesired positions, e.g. at the plasma generator cable connection. It can be destroyed).
- Sparkovers

If such operation malfunctions occur, first carry out the following steps:

1. Switch off the device, see page 12.
2. Allow the device to cool down to ambient temperature.
3. Then check the device visually for external damage.
4. If no damage is visible, switch the device on again.

If the device still does not operate trouble-free, shut down the device and contact After Sales Service.

9.3 After Sales Service

If the device does not work correctly, send it to **relyon plasma** GmbH for examination.

After Sales Service address:

- see rear side of Operating Instructions.

9.4 Overview of malfunctions / faults

Malfunction / fault	Cause	Remedy
plasma cannot be switched on or plasma ceases during operation	Current supply	(customer provided)
	An internal fault has occurred	De-energize the device. Switch on again
	Mains fuse has tripped	Check mains fuse, provide more powerful fusing if necessary
	Mains cable interrupted	Check mains cable
	Wear of nozzle and electrode	Check nozzle and electrode for wear, replace if necessary
	Short-circuit, the plasma generator is defective	Contact After Sales Service
	Cable breakage	Check HV cable from media supply to the plasma generator for possible cable breakage
		Problem cannot be eliminated: Contact After Sales Service

10 Environment

10.1 Disposal



Do not forget environmental protection.

Used electrical and electronic devices must not be disposed of together with household waste.

- The device contains valuable raw materials that can be recycled. Always hand in the device therefore to an appropriate acceptance point.

11 Conformity / standards

11.1 CE



Our EC Declaration of Conformity.

The marking is on the type plate on the bottom side of the device housing.

11.2 Product standards

The device complies with the following provisions and standards:

2004/108/EC EC-EMC Directive Guideline of the European Council for harmonization of the legal specifications of the member states with regard to electromagnetic compatibility.	
2006/95/EC EC Low Voltage Directive Directive 2006/95/EC of the European Parliament and Council dated December 12th, 2006 for harmonization of the legal requirements of the member states with regard to electric equipment for use within specific voltage limits.	
EN 55011 (2007 + A2:2007) transient emissions, limit group 2, class A	
EN 61000-6-2 (2005) Immunity from disturbance	
Type of protection IP20	IEC 60529

12 Spare parts

Item-no	product description
77043402	PB3 PLASMA GENERATOR PG-31 (2m)
78879101	PB3 PLASMA GENERATOR PG-31 (1m)
77071600	SPACER CERAMIC BUSH
74532300	PB3 CERAMIC BUSH
77071900	PB3 COUPLING NUT

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