

TruPlasma RF System

**RF Series**  
**1000 / 3000**

RF complete solution

Accuracy you can rely on

**TRUMPF Hüttinger**  
generating confidence



# 1000



## Plasma etching

Through material removal, the structures for electronic components are carved out from thin layers. Thereby produced are, for example, conductor tracks or transistors. By ionizing the molecules of a process gas, ions are formed that are accelerated towards the substrate surface in the electric field of the plasma.

# When your application decides.

Then you decide for the TruPlasma generators from TRUMPF Hüttinger.

Unrivalled energy efficiency and robustness guarantee outstanding process stability.

The TRUMPF Hüttinger system concept opens many new possibilities for you.

Be it in the production of semiconductor components, microchips, solar cells or flat-panel displays.

## Ion beam source

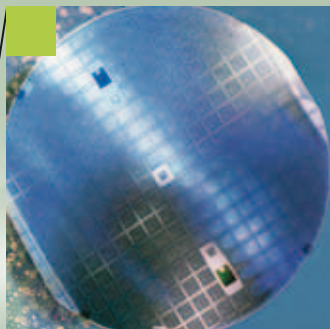
In an RF plasma, the process gas is first ionized; energetic ions are then extracted and accelerated through a lattice or electrode system.

With this ion beam, work pieces can be cleaned, etched or coated.

## Photoresist plasma incineration

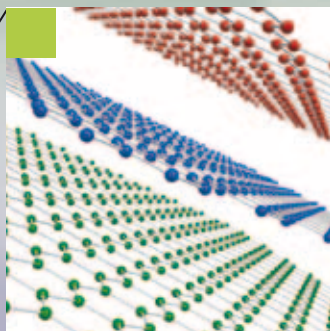
With plasma etching, locations that are to remain as a component are protected by a photoresist. This is then removed through cold burning or incineration in an oxygen plasma so that the next layer can be removed for components or conductor tracks.

# 3000



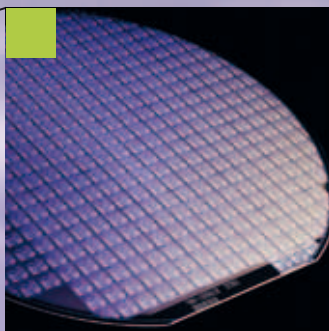
### Reactive ion etching

The process (RIE) is used in the manufacture of semiconductor elements, especially for microelectromechanical systems (MEMS). RIE is a combination of etching and protection of the side surfaces. It can be used to create deep microscopic holes.



### ALD

This process can be used to apply extremely uniform thin layers. Each individual atomic layer made of adsorbing precursor is deposited and affixed with a plasma-activated reactant. The result is a uniquely precise control of the layer composition.



### PECVD

A versatile process in the production of microelectronic components, flat-panel displays, solar modules and optical components. Metallic, semi-conducting or insulating layers can be applied. Even complex layer systems can be realized.

### RF sputtering

The material of a metallic or ceramic cathode is atomized by the ions of a plasma. The atomized material then forms the desired layer. An RF plasma is the only way to use electrically isolating ceramic targets and thus opens the widest choice of materials.



### Hard-material and wear-protection layers

To protect metal workpieces from wear, they can be coated in a plasma with a diamond-like carbon (DLC) or other hard coating. Used as starting material is, e.g., acetylene gas, which is broken down into its atomic components and forms the DLC layer. The desired hardness of the layer is often made possible by the high bias voltage that forms on the work piece in the RF plasma.

1000



# Unique on the market – the benefits for you.

For the manufacture of complex micro-structures, reproducible processes are the key to consistent results. Thanks to a stable output power and high control accuracy, the TruPlasma RF Series 1000 / 3000 provides ideal conditions for reliable operation.

Unique on the market, TRUMPF Hüttinger's high-frequency combiner technology CombineLine ensures an exceptionally stable energy supply.



## 09 Fits in every system

High power density in a very small space:  
compact 19 inch or half 19 inch design.

3000

## 01 Stable, reproducible processes

- The integrated CombineLine technology and the high accuracy prevent plasma fluctuations; contamination caused by particles is counteracted.
- "Smart" Auto Frequency Tuning – the most intelligent solution for your process adaptation: no trial and error, consistently matched parameters!

## 02 No restrictions on cable length

A change to your plasma process (gas mixture, pressure, etc.) now no longer requires a change to the cable length. The new CombineLine coupler guarantees a constant power supply.

## 03 Robustness

Self-protection included: Thanks to the patented CombineLine coupler, an interference-free process power supply is possible for the first time. With reflected power as well, the power semiconductors are located in a safe operating area (SOAR – Safe Operating ARea). High reliability is the result.

## 04 Excellent efficiency

Up to 80% (depending on operating conditions). You can thereby reduce your current energy costs by up to 50% of what is typical on the market. This makes a faster return on investment possible.

## 05 Global installation

Plug & Play: The wide-range power supplies the different voltages in various countries (depending on model, up to 200 - 480 VAC) without needing reconfiguration.

## 06 Cooling concept

Through an ingenious cooling concept, we achieve:

- maintenance-free or low-maintenance products
- ambient air not influenced by warming and contaminants
- low failure rates
- increased efficiency
- operation in clean rooms

## 07 Individual process adaptations

Synchronization possibilities and a number of configurations can be ideally adapted to your specific processes.

## 08 System integration

Simple and economical through various interfaces, such as analog, RS 232/485, DeviceNet, Profibus, EtherCAT. The configurable analog interface simplifies integration in existing systems.

# Matchbox

## 02 Control platform

The advanced type of digital signal processing (DSP – digital signal processor) is responsible for excellent process monitoring. A digital control platform, equipped with FPGA (field-programmable gate array), enables real-time measurements and processing of all operating parameters as well as fast communication via all interfaces.

## 01 Matching algorithm

Innovative, intelligent algorithm for fast and direct impedance matching to 50 ohm. This guarantees stable and repeatable matching. Both the response as well as the speed are displayed on the visualized Smith chart.

# Intelligent matching through real-time measurement

## 08 Flexibility

The operator-specific matchbox parameters can be preset in a detailed and intuitive way and stored as a "parameter set." They are used in automatic operation. This makes possible a very short tuning time and optimized execution, even with difficult and sensitive processes.

## 07 Operating software

The improved graphical operating software enables the complex graphical display of the load and matchbox impedance in the Smith chart. The RF output parameters, including frequency and phase shift as well as input parameters of magnitude and phase, are displayed in a real-time oscilloscope and can also be stored in an ASCII file for further evaluations.

## 06 TRUMPF SystemPort

The SystemPort enables a closed control circuit by measuring the RF signal directly at the input and output of the matchbox. All measurement values are available to the RF generator. Process parameters can thereby be better monitored, the matchbox protected and early arc detection ensured. The entire RF system can thus be controlled via a single generator interface.

### 03 Cooling

Greater reliability and increased protection through wear-free cooling sensors.

Optimum detection of:

- flow
- temperature
- power losses

### 04 Multi-frequency generators in combination with a system

The matchbox supports functions that simplify work when using multiple power sources with a load. Plasma chambers that are equipped with multiple power sources benefit from this functionality.

### 05 Real-time measurement of the high-frequency input and output power

Real-time measurement of the RF power shows the dynamic impedance change of matchbox and load. Sensors and software of the matchbox enable the measurement of the actual voltage and current amplitude as well as the actual phase shift ( $360^\circ$ ), together with dynamic real-time frequency measurement. In addition, the matchbox can be equipped with a DC-bias sensor.



#### A known problem:

Important for optimum energy transfer is the matching of the plasma process, which can be considered to be a complex load. Impedance changes of the load can be caused by, e.g., plasma ignition and change, changes to the gas composition, etc.

The matchbox is an active tuning network which ensures "optimal loading" of the RF power source under variable load conditions. It detects the impedance and automatically matches it. No

mismatching – with the undesirable properties – can occur. Thus, the generator always "sees" the optimum impedance of 50 ohm.

The matchbox is controlled via the generator, e.g., with the help of the TruControl Power operating software; direct control, e.g., with the TruMatch software, is also possible.

# 1000 Series

## What's behind it?





RF output	TruPlasma RF 1001 (G2/13)	TruPlasma RF 1002 (G2/13)	TruPlasma RF 1003 (G2/13)
Output power range	1 W ... 1000 W	1 W ... 2000 W	1 W ... 3000 W
Maximum reflected power	600 W	600 W	600 W
VSWR 1.1 : 1	100% of the nominal power	100% of the nominal power	100% of the nominal power
VSWR 1.5 : 1	100% of the nominal power	100% of the nominal power	95% of the nominal power
VSWR 2 : 1	100% of the nominal power	100% of the nominal power	66% of the nominal power
VSWR 3 : 1	100% of the nominal power	75% of the nominal power	50% of the nominal power
VSWR infinite	60% of the nominal power	30% of the nominal power	20% of the nominal power
Output frequency	13.56 MHz $\pm$ 0.005%	13.56 MHz $\pm$ 0.005%	13.56 MHz $\pm$ 0.005%
Output impedance	50 $\Omega$	50 $\Omega$	50 $\Omega$
"Harmonic signals at full nominal output power at 50 $\Omega$ non-reactive load"	-40 dBc	-40 dBc	-40 dBc
"Spurious signals at full nominal output power at 50 $\Omega$ non-reactive load"	-50 dBc	-50 dBc	-50 dBc
Power accuracy at 50 $\Omega$ load <sup>1)</sup>	$\pm$ 1 W or $\pm$ 1%	$\pm$ 1 W or $\pm$ 1%	$\pm$ 1 W or $\pm$ 1%
Fluctuation at 50 $\Omega$ load <sup>1)</sup>	$\pm$ 1 W	$\pm$ 1 W	$\pm$ 1 W
"Reproducibility of the output power at 50 $\Omega$ load (device to device) <sup>1)</sup> "	$\pm$ 2 W or $\pm$ 1%	$\pm$ 2 W or $\pm$ 1%	$\pm$ 2 W or $\pm$ 1%
RF output	MN; 7/16	MN; 7/16	MN; 7/16

### Operating mode

Regulation mode	Forward power, load power, external voltage		
Pulse mode	1 Hz to 50 kHz, internal and external signal source		
Frequency agility	$\pm$ 678 kHz ( $\pm$ 5%) (optional)		
Arc management	yes (optional)	yes (optional)	yes (optional)

### Interfaces

Interfaces	Analog; DeviceNet; RS232/485, SystemPort or Analog; EtherCAT; RS232/485, SystemPort or Analog; Profibus; RS232/485, SystemPort		
Sync (CEX; pulse; arc)	yes	yes	yes

### Mains

Mains voltage	200-480 VAC $\pm$ 10%, 3 phases + PE		
"Overall efficiency of mains to RF output at full nominal power at 50 $\Omega$ load and 480 VAC"	72% (typ.)	80% (typ.)	80% (typ.)
Power factor (cos $\varphi$ )	0.95	0.95	0.95
Mains power consumption at full nominal power at 50 $\Omega$ load	1.8 kVA	3.1 kVA	4.3 kVA

### Operating conditions

Ambient temperature	5 $^{\circ}$ C ... 35 $^{\circ}$ C	5 $^{\circ}$ C ... 35 $^{\circ}$ C	5 $^{\circ}$ C ... 35 $^{\circ}$ C
Cooling medium	Water	Water	Water
Min. throughput with 13.56 MHz operation	4 l/min	4 l/min	4 l/min
Max. water pressure	7 bar	7 bar	7 bar
Max. differential pressure	1.1 bar	1.1 bar	1.1 bar

### Housing

Protection class	30	30	30
Dimensions (W x H x D in mm)	"216 x 128.5 x 405 (3 HU)"	"216 x 128.5 x 405 (3 HU)"	"216 x 128.5 x 405 (3 HU)"
Weight	18 kg	18 kg	18 kg

### Standards and directives

SEMI F47 (power sag), SEMI S2 (safety interlock), UL, CSA, CE, RoHS

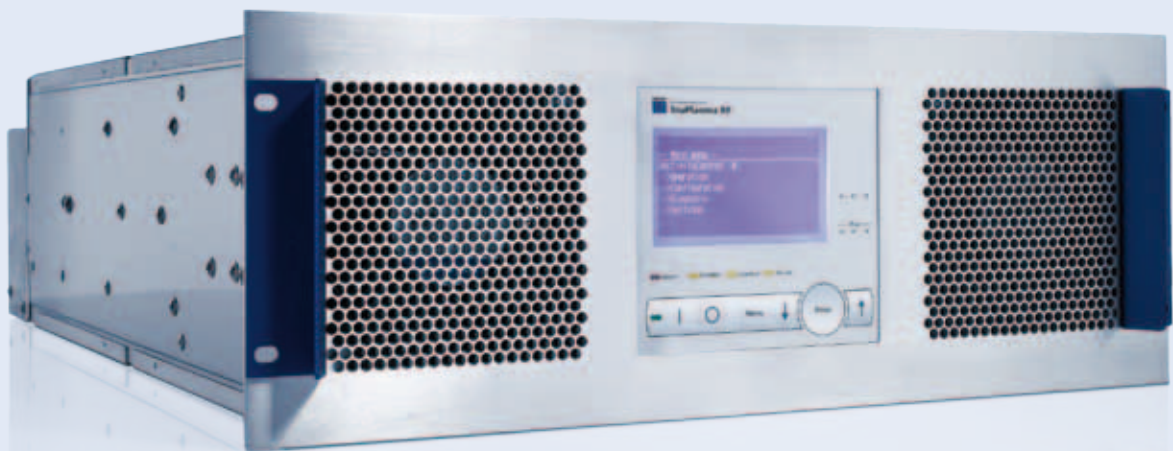
1) The larger value is valid

# 3000 Series



TruPlasma RF 3006 (G2)

## What's behind it?



TruPlasma RF 3012

RF output	TruPlasma RF 3006 (G2/13)	TruPlasma RF 3012	TruPlasma RF 3024
Output power range	1 W ... 6000 W	1 W ... 12000 W	1 W ... 24000 W
Maximum reflected power	1200 W	2400 W	4800 W
VSWR 1.1 : 1	100% of the nominal power	100% of the nominal power	100% of the nominal power
VSWR 1.5 : 1	95% of the nominal power	100% of the nominal power	100% of the nominal power
VSWR 2 : 1	66% of the nominal power	75% of the nominal power	75% of the nominal power
VSWR 3 : 1	50% of the nominal power	60% of the nominal power	60% of the nominal power
VSWR infinite	20% of the nominal power	20% of the nominal power	20% of the nominal power
Output frequency	13.56 MHz $\pm$ 0.005%	13.56 MHz $\pm$ 0.005%	13.56 MHz $\pm$ 0.005%
Output impedance	50 $\Omega$	50 $\Omega$	50 $\Omega$
"Harmonic signals at full nominal output power at 50 $\Omega$ non-reactive load"	-40 dBc	-50 dBc	-40 dBc
"Spurious signals at full nominal output power at 50 $\Omega$ non-reactive load"	-50 dBc	-40 dBc	-50 dBc
Power accuracy at 50 $\Omega$ load <sup>1)</sup>	$\pm$ 2 W or $\pm$ 1%	$\pm$ 4 W or $\pm$ 1.5%	$\pm$ 8 W or $\pm$ 1.5%
Fluctuation at 50 $\Omega$ load <sup>1)</sup>	$\pm$ 2 W	$\pm$ 4 W with 8,000 W	$\pm$ 8 W with 16,000 W
"Reproducibility of the output power at 50 $\Omega$ load (device to device) <sup>1)</sup> "	$\pm$ 4 W or $\pm$ 1%	$\pm$ 4 W or $\pm$ 1%	$\pm$ 8 W or $\pm$ 1%
RF output	LC	7/8" EIA	1 5/8" EIA

Operating mode			
Regulation mode	Forward power, load power, external voltage		
Pulse mode	1 Hz to 50 kHz, internal and external signal source		
Frequency agility	$\pm$ 678 kHz ( $\pm$ 5%) (optional)	No	No
Arc management	yes (optional)	yes (optional)	yes (optional)

Interfaces			
Interfaces	"Analog; DeviceNet; RS232/485, SystemPort or Analog; EtherCAT; RS232/485, SystemPort or Analog; Profibus; RS232/485, SystemPort"	"Analog, RS-232/485, Profibus, Ethernet, SystemPort Optional: DeviceNet®, Matchbox FOC, EtherCAT®"	
Sync (CEX; pulse; arc)	yes	yes	yes

Mains			
Mains voltage	200-480 VAC $\pm$ 10%, 3 phases + PE	"200 ... 220 VAC $\pm$ 10% or 400 ... 480 VAC $\pm$ 10% 3 phases + PE"	
"Overall efficiency of mains to RF output at full nominal power at 50 $\Omega$ load"	80% (typ.) (at 480 VAC)	"> 78% (at 400 VAC) > 77% (at 200 VAC)"	"> 75% (at 400 VAC) > 74% (at 200 VAC)"
Power factor (cos $\varphi$ )	0.95	> 0.93	> 0.93
Mains power consumption at full nominal power at 50 $\Omega$ load	7.9 kVA (at 480 VAC)	"16.6 kVA (at 400 VAC) 16.8 kVA (at 200 VAC)"	"33.3 kVA (at 400 VAC) 33.6 kVA (at 200 VAC)"

Operating conditions			
Ambient temperature	5 °C ... 35 °C	5 °C ... 40 °C	5 °C ... 40 °C
Cooling medium	Water	Water & air	Water & air
Min. throughput with 13.56 MHz operation	8 l/min	10 l/min	20 l/min
Max. water pressure	7 bar	7 bar	7 bar
Max. differential pressure	1.1 bar	2 bar	2 bar

Housing			
Protection class	30	20	20
Dimensions (W x H x D in mm)	"436 x 128.5 x 458 (19" rack mount, 3 HU)"	"483 x 176.5 x 717 (19" rack mount, 4 HU)"	"482 x 352 x 746 (19" rack mount, 8 HU)"
Weight	38 kg	57 kg	117 kg

Standards and directives	"SEMI F47 (power sag), SEMI S2 (safety interlock), UL, CSA, CE, RoHS"	SEMI F47 (power sag), CE, RoHS	
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1) The larger value is valid

# Matchbox

## What's behind it?



TruPlasma Match 1000 (G2/13)

RF	TruPlasma Match 1000 (G2/13)		
	1/3/6 kW model	12 kW model	24 kW model
RF output power CW operation	1, 3, 6 kW	12 kW	24 kW
RF voltage	2400 V RMS	3500 V RMS	5500 V RMS
RF current	50 A RMS or 90 A RMS	130 A RMS	170 A RMS
RF frequency	13.56 MHz	13.56 MHz	13.56 MHz
Sensors	"Magnitude / phases RF output voltage RF output current DC bias voltage"		
RF input	7/16" or customer-specific	"1 5/8" EIA or 7/8" EIA or 13/30"	
RF output	Multi-contact / customer-specific, at side / bottom	Customer-specific, at side / bottom	

#### Interfaces

Digital	"USB-Service, EtherNet, SystemPort (TRUMPF generator control), RS232/485"
Option	"Analog / digital (optional) Profibus (optional) ECAT (optional)"

#### Mains

Mains voltage	24V DC, 48V DC, 87÷264V single phase
Mains frequency	47 Hz / 63 Hz

#### Operating conditions

Cooling medium	Air	Water
Water pressure	--	max. 6 bar
Throughput	--	>3.5 l/min Flow sensor present

#### Housing

Dimensions (W x H x D in mm)	244 x 149 x 505 mm	400 x 230 x 560 mm	507 x 257 x 546 mm
	368 x 165 x 450 mm		
Weight	8 kg	30 kg	
Protection class	IP 20		

## 01 Smart Auto Frequency Tuning

Perfect interplay with the novel and intelligent algorithm in the matchbox.

## 02 Closed loop control

The additional sensors in TruMatch enable further process control parameters and arc detection directly at the RF supply line of the electrode.

# The TRUMPF RF system

The system concept stands in the foreground for TRUMPF Hüttinger. All components are matched to one another and can also be used individually. The user interface (GUI) was further developed with this in mind: it intuitively visualizes the process and is easy to operate for configuration and process interventions. With a clear operating concept, the number of parameters could be reduced and convenient operation realized.

Various interfaces, including EtherCAT among others, enable the integration of the TRUMPF Hüttinger generators and the matchbox, even in existing process environments.

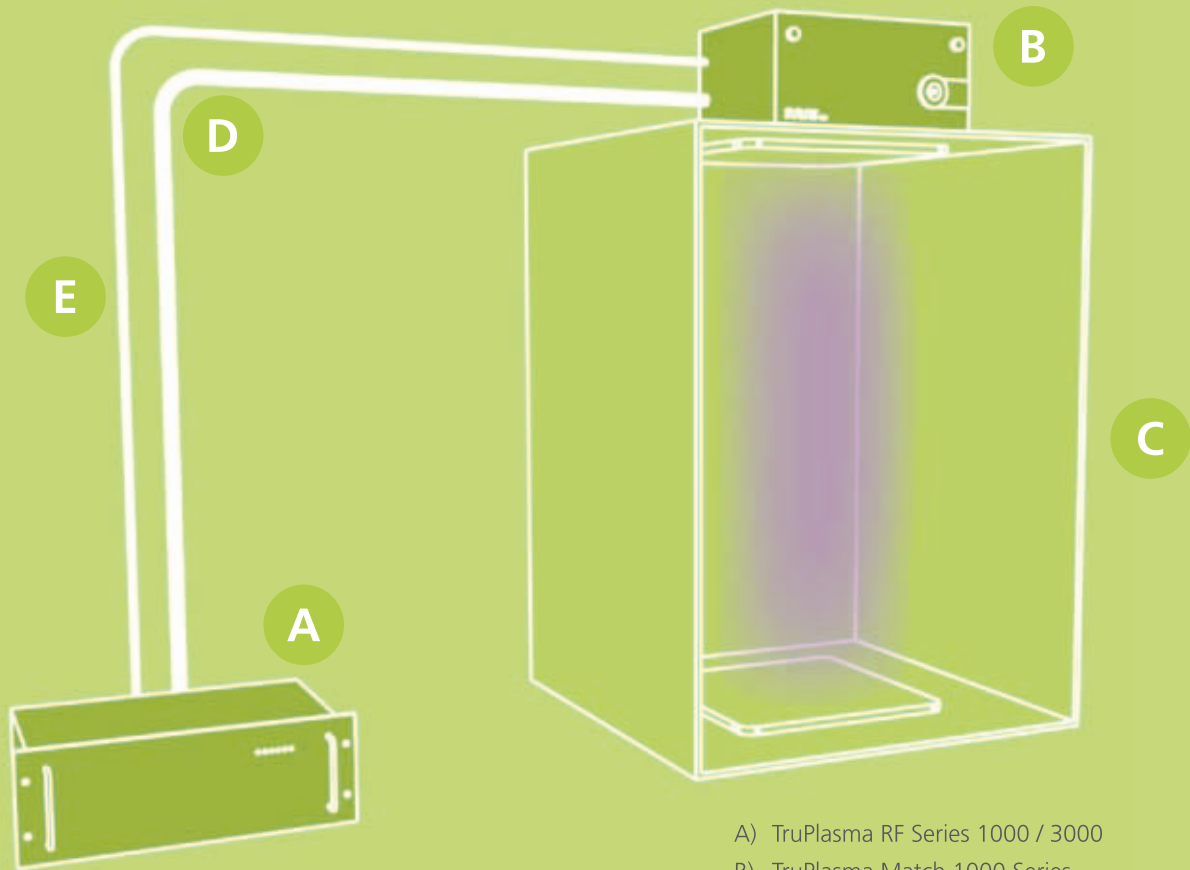
TRUMPF Hüttinger offers the complete RF system solution: synchronization and joint operation of multiple generators. Synchronization can be performed using an internal or external signal. It is thereby possible to forgo a higher-order phase shifter or a higher-order pulse signal source.



## 09 Best efficiency through system solution

## 08 Monitoring functions

Internal oscilloscope, trending function, system protection ( $I_{rf}$  current,  $U_{rms}$ ,  $U_{eff}$ , DC BIAS), load impedance measurement.



- A) TruPlasma RF Series 1000 / 3000
- B) TruPlasma Match 1000 Series
- C) Plasma system
- D) TRUMPF SystemPort
- E) High-frequency cable



### 03 Robust system construction

### 04 High process stability

### 05 Real-time measurement of all process parameters

### 06 CombineLine technology

Avoids plasma instability and enables high accuracy in the entire power range independent of cable length.

### 07 Fast matching

Fast, stable and reproducible matching - even in difficult processes.

# At your side: Service and more!

TRUMPF Hüttinger is a global leader in process power supplies for plasma applications, induction heating, CO<sub>2</sub> laser excitation. You can find our sales and service subsidiaries worldwide in Europe, America and Asia. Company headquarters are in Freiburg. Hüttinger has been a member of the TRUMPF Group since 1990.





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## Service – worldwide and around the clock

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The best service, so the saying goes, is the service you don't need. True words. But it's a good feeling to know that you always have a TRUMPF Hüttinger service team within reach. With specialists who can come to you at all possible - and impossible - hours. We support you with maintenance work, repairs and spare part requests. Regardless of where in the world your company is located and regardless of the time.



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## Optional service offerings – when you'd like a little bit more security

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Do you want maximum reliability and maximum availability for your generators? Then our optional service offerings are right for you! We offer a broad range of service agreements – from a hotline contract to a full service agreement that covers all costs for any necessary spare parts and services. Other additional options, such as urgent repairs, round out our offerings and keep the risk of production downtime to a minimum.



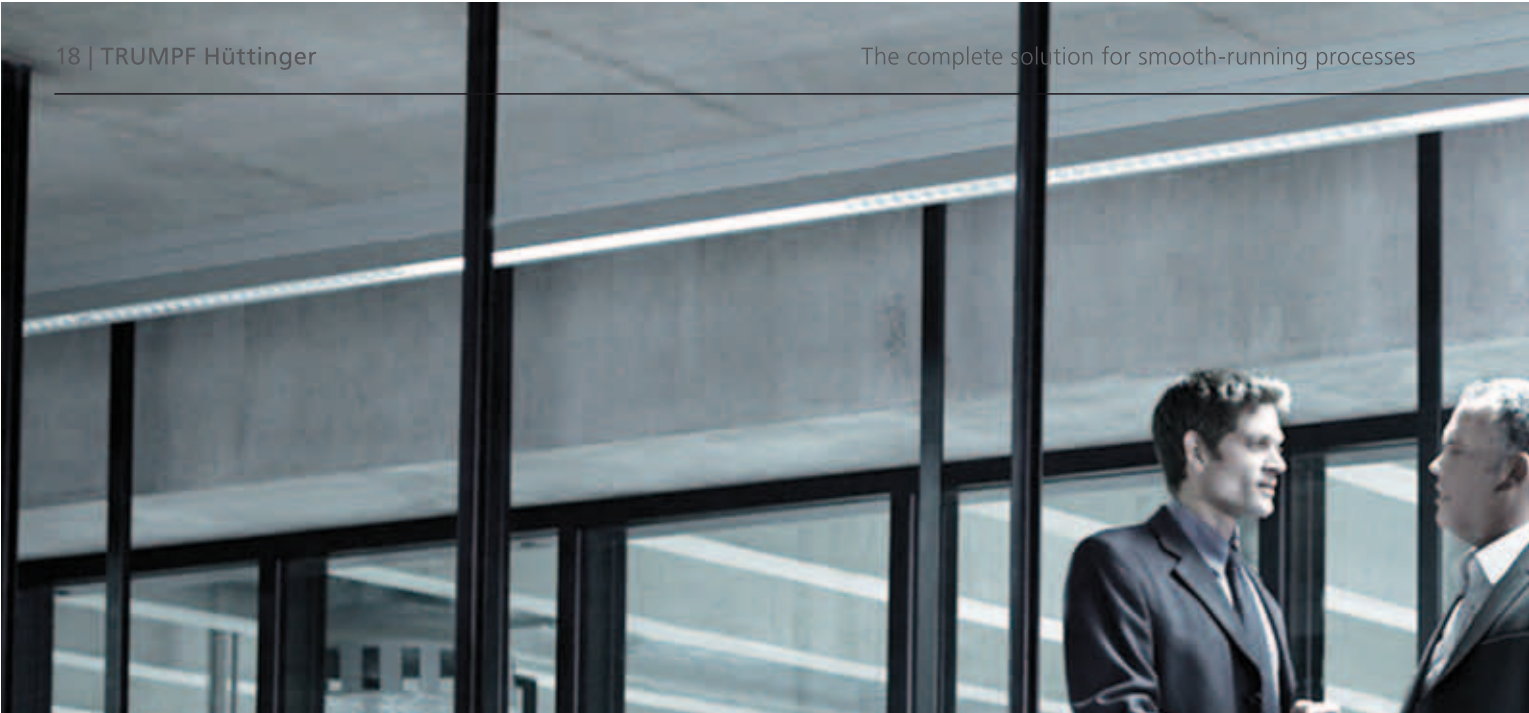
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## Training

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Well-trained personnel pay for themselves. Because qualified staff fully utilize the potential of our generators and thereby create a direct competitive advantage for you. Our basic training classes convey the knowledge needed to efficiently operate your generators and how to perform repairs independently. With our application training courses, our application experts are available exclusively to you for an entire day and show how you can optimally match your generator to your process.

Whether at your location or on site with us – we always tailor our offer exactly to your needs: so that you can maximize your benefits from the training.




# Our energy for your processes

Production processes have been our focus for more than 90 years. Your requirements serve as our benchmark. With this experience and profound know-how, we ensure the reliability and stability that you need in order to rely on your processes. We work daily to optimize the power supply in the process flow. Our processes, from research and development to production, are subject to constant quality controls.

As a result, we can be sure that optimum results are always achieved.

For you – and for us!





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## Quality

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For us, quality means that you are satisfied and your expectations are met. Serving as the basis are the deep-rooted quality awareness of our employees and a creative company culture. But our demand for quality goes further: in our own test and qualification center that spans more than 1000 m<sup>2</sup>, our application engineers work every day to ensure that our product quality is constantly optimized. All of our products, whether for standard or customer-specific applications, are extensively tested and optimized. Plasma and HALT chambers as well as an EMC test station allow for realistic tests. And, if necessary, we also assist our customers on-site with consulting, training and service.



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## Application consulting

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Standard solutions are not part of your specific application? Then you've come to the right place! We meet customer-specific requirements quickly and precisely – through custom solutions. We offer in-depth consulting, requirement analysis and the development of a custom, cost-optimized solution. This is guaranteed by our experienced application engineers and technicians.



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## Resource efficiency

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Environmentally friendly, energy-saving products – that is the future. Our generators do more than produce power: thanks to their high efficiency, they also conserve energy. Both our customers and environment benefit from this. At TRUMPF Hüttinger, resource efficiency means much more: we apply this to our company as well. Buildings, structures and the use of resources are shaped by consistent sustainability. Our SYNCHRO production system, for example, systematically detects and eliminates waste. We plan, construct and operate our office and production buildings in an energy efficient manner. The circle of our efficient actions is thereby completed.

## Process energy from TRUMPF Hüttinger – solutions for an advanced world

Modern industrial production and, thus, life as we know and value it – would not be possible without our generators. Process power supplies from TRUMPF Hüttinger play an essential role in many key processes in research, development and production. Our experience is incorporated in every newly developed solution: unique expertise from the areas of induction heating and plasma and laser excitation.

Particularly for the development of optimum plasma energy sources, decades-long process know-how and experience are the key to success. We are thereby positioned on the front line in the opening of new and optimization of existing application fields.

Innovative strength, economic independence and proximity to customers embody our tradition as a family business. Founded in the year 1922 by Fritz Hüttinger, we have been part of the TRUMPF Group since 1990. With approximately 650 employees at the headquarters in Freiburg in Breisgau and in six subsidiaries in Europe, Asia and the USA, TRUMPF Hüttinger is present around the world.

Together with you, we have been advancing the development of process energy for decades. The reward for the effort: a potential of mutual trust that may be unmatched in the industry. It fascinates us to see everything that you create with our process energy.



Energy is flowing here: The production and administration building in Freiburg.

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**TRUMPF Hüttinger**  
generating confidence

