Microwave Oscillators and Atmospheric Pressure Plasma Needle

We welcome companies interested in utilizing the technology developed by Plasma Applications Co., Ltd., a research and development-based venture originating from Shizuoka University. This technology includes microwave oscillators operating at frequencies of 915MHz, 2.45GHz, and 5.8GHz, with output ranging from 10W to 250W, along with their proprietary microwave atmospheric pressure plasma needle.

The key features of this technology are as follows:

- Simple and compact hardware design, making it cost-effective.
- Operates under atmospheric pressure conditions.
- Capable of stable temperature control.
- Low power consumption and potential for power and wiring-free applications.
- Enables processing of fine details (minimum 2mm diameter).
- Environmentally friendly and safe for human use.

We offer customization of any of our products to meet customer's needs.
We often collaborate with other companies by offering our expertise during various phases of product development, weather it is in the field of plasma physics (experiment setup, data measurement, etc.), and/or in microwave design and development.

Our Technology

Our microwave amplifiers utilize LDMOS FET and/or GaN FET mainly for ISM band applications. We have produced ISM band oscillators in the SOA series, with power options ranging from 10W to 250W.
To simplify usage for engineers unfamiliar with microwave technology, we provide the MWPS series, a Microwave Power Supply Unit equipped with all necessary components to simply plug the unit to power socket, connect coaxial cable and start testing. In combination with our Auto-Tuner (ADS series) you can be sure that most of the microwave power is deliver to the load.
The SOA and MWPS series are suitable for applications requiring precise control over frequency and output power, such as plasma generation and fine chemicals.
Our Microwave Atmospheric Pressure Plasma Needle (PLN-01) generates needle-shaped, low-temperature plasma at 2.45GHz with input power ranging from 10W to 25W. It facilitates various plasma processes, including organic impurity removal, etching, and carbon-based material film deposition. Increasing the microwave input to 40W or higher transforms it into thermal plasma, allowing for metal wire melting.
This plasma needle's adjustability between low-temperature and thermal plasma opens up exciting opportunities for application development. Its versatility allows for exploring innovative uses for the technology."

【Microwave Amplifier with Oscillator: SOA Series】

Features:

Efficiency: 55% Typ., ON/OFF control of microwave output, adjustable output power and frequency via DC voltage, built-in isolator, output power and reflected power monitoring, thermal overheat output signal, external oscillator switching, and pulse control capabilities.

・2.45GHz 50W variable output oscillator (SOA-VCO2450050-01)

Specification

Item		Spec	
Type		SOA-VCO2450050-01	SOA-VCO2450100-01
Fixed frequency range		2.4GHz～2.5GHz	
Output power		0～50W (CW) Typ.	0～100W (CW) Typ.
Input Power	Voltage	+50VDC (GaN FET)	+28VDC (LDMOS FET)
	Current	ON：2.5A、 OFF：300mA	ON：9.0A、 OFF：1.5A
Outer dimension （w/o projecting part）		W88mm × D132mm × H27mm	W110mm × D135mm × H215mm
Wight		Under 1,200g	Under 900g
Interface		RF output：SMA connector	
		Power：D-sub connector	
Operating temperature range		-10°C～+45°C (Mounting surface temperature)	

【Microwave Power Supply Unit : MWPS Series】

Features:

This model is a device equipped with a variable output microwave oscillator (e.g., SOA-VCO2450050-01), heat sink, cooling fan, and AC/DC power supply. Controls for frequency and output power as well as RF output ON/OFF control are placed on the front panel for easy access. LCD display shows current settings and/or forward and reverse power monitor reading.

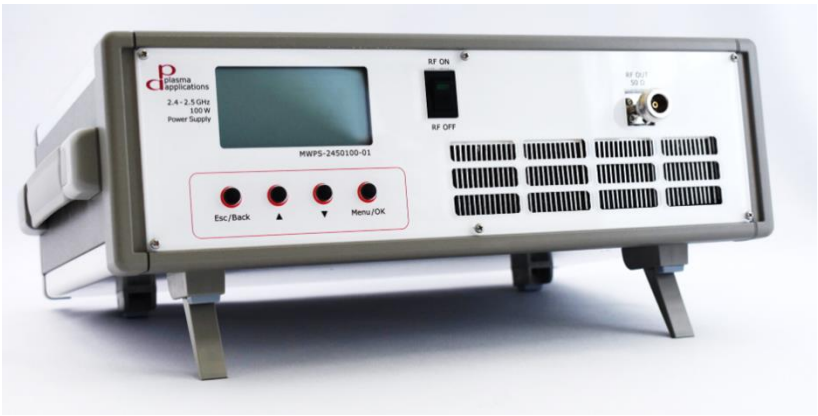
As an option, DC output proportional to forward power, reverse power, and frequency is available. Some customers use this to record forward and reverse power, and/or frequency during the experiment.

This microwave power supply unit can be used out of box.

MWPS series microwave power supply can be configured for several frequency ranges (i.e. 915 MHz, 2.45 GHz, etc.) and output powers (50W, 100W, 250W)

・2.45GHz 50W Microwave Power Supply Unit (MWPS-2450050-01)

・2.45GHz 100W Microwave Power Supply Unit (MWPS-2450100-01)



Specification

Item	Spec	
Type	MWPS-2450050-01	MWPS-2450100-01
Main components	Output Variable Solid-State Microwave Oscillators Heat sink/Cooling fan/AC-DC converter/LCD monitor	
AC Power	100 V, 2.5 Amax	100 V, 5.0 Amax
LCD Monitor	Displays input and reflected power, oscillator frequency, and oscillator ON/OFF	
Microwave Output	Variable from 0W～50W	Variable from 0W～100W
Oscillation frequency	Variable from 2.4 GHz to 2.5 GHz	
Input/Output Impedance	50 Ω	
Output Connector	SMA connector	
Outer dimension	W150mm × D200mm × H120mm	W320mm × D245mm × H100mm
Weight	2.3 kg	4.9 kg

SOA and MWPS Series Product List

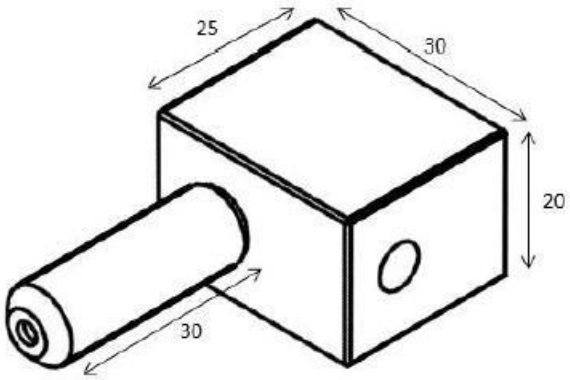
1	2.45GHz 10W Fixed Output microwave oscillator	SOA-FB245010-01
2	2.45GHz 50W Fixed Output microwave oscillator	SOA-FB2450050-01
3	2.45GHz 100W Fixed Output microwave oscillator	SOA-FB2450100-01
4	2.45GHz 250W Fixed Output microwave oscillator	SOA-FB2450250-01
5	915MHz 50W Variable Output microwave oscillator	SOA-VCO915050-01
6	915MHz 100W Variable Output microwave oscillator	SOA-VCO915100-01
7	915MHz 250W Variable Output microwave oscillator	SOA-VCO915250-01
8	2.45GHz 50W Variable Output microwave oscillator	SOA-VCO2450050-01
9	2.45GHz 100W Variable Output microwave oscillator	SOA-VCO2450100-01
10	2.45GHz 250W Variable Output microwave oscillator	SOA-VCO2450250-01
11	915MHz 50W microwave oscillator unit	MWPS-915050-01
12	915MHz 100W microwave oscillator unit	MWPS-915100-01
13	915MHz 250W microwave oscillator unit	MWPS-915250-01
14	2.45GHz 50W microwave oscillator unit	MWPS-2450050-01
15	2.45GHz 100W microwave oscillator unit	MWPS-2450100-01
16	2.45GHz 250W microwave oscillator unit	MWPS-2450250-01

【Plasma Needle Generator PNL-01】

By utilizing 2.45GHz microwave and argon gas, it is possible to generate needle-shaped plasma under atmospheric pressure. The antenna is housed inside a metal nozzle (the tubular protrusion on the right side of the diagram) to minimize external leakage of the microwave.

The operation is as follows:

- Connect the microwave power supply and PNL-01 with an SMA cable (For better operation we recommend using impedance matching i.e. double slug tuner DST). Connect the Argon gas supply through mass flow controller to PLN-01. Setup gas flow of Argon in rage 500 – 3000 sccm. Energize the PLN-01 by switching on the microwave power supply and setting the microwave power from 10W to 30 W.
- Changing the discharge gas type, flow rate, and microwave input alters the needle's length. Moreover, the microwave input for transitioning between low-temperature plasma and thermal plasma also changes.
- By irradiating the sample surface with low-temperature plasma needle generated by mixing reactive gases like oxygen or hydrogen with argon, the buffer gas, small-area plasma processing can be performed.



PNL-01 Dimensions（Unit:mm）

Specification

Item	Spec
Microwave Frequency	2.45 GHz
Microwave Input	5～30 W
Argon gas flow rate	500～3000 SCCM
Microwave input connector	SMA
Tube fittings for discharge gas supply	Swagelok
The temperature at the tip of the argon plasma needle*.	50～100 °C

* The temperature at the tip of the plasma needle strongly depends on the microwave input, gas flow rate, and the type of mixed gas.

Comparison with Low-pressure Plasma Generation Devices
Requires expensive vacuum equipment, skilled operators, and additional effort for operation.

Comparison with Other Atmospheric Pressure Plasma Devices
Many other atmospheric pressure plasma devices utilize dielectric barrier discharges, mainly designed for large-area applications, thus requiring substantial power.
Controlling the plasma can be challenging, leading to issues with temperature stability, among others.
Ozone generation is a significant problem as a byproduct of plasma generation and reaction gases.
Some plasma torch applications have emerged, but they face such challenges as:

- ・High power consumption.
- ・Limited temperature control range (often involving thermal plasma) or difficulty in controlling discharge shape and electrode wear.
- ・Many utilize expensive helium or helium-mixed gases, presenting additional obstacles.

For more details, please don't hesitate to contact us. We are dedicated to providing innovative solutions to meet the needs of our business partners.

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