Impedans

PLASMA MEASUREMENT

Instrument Catalogue

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Plasma Measurement to Understand and Control the Future

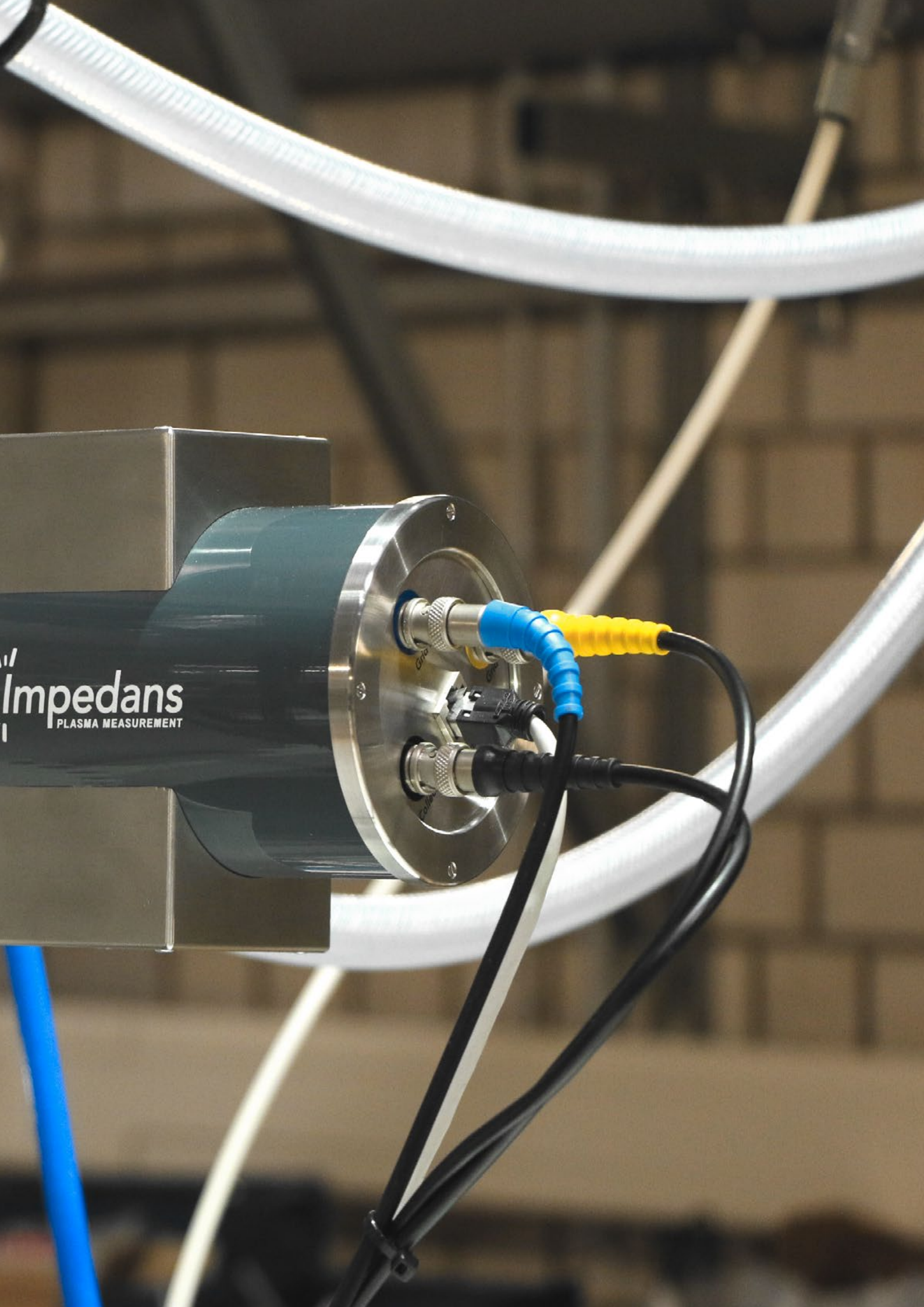
Impedans focus exclusively on innovative plasma measurement systems incorporating unique expertise built up over many years of experience. We believe the right plasma measurement products and ongoing expertise will enable our customers to better understand and control their processes. The knowledge and understanding gained by our customers help them create value and stay ahead of the competition.

Substrate Level Measurement

Interactions of ions at a substrate play a major role in plasma processing. The ability to quantify the flux and energy of ions impacting a surface is crucial for optimising process conditions.

System Comparison Chart

	Ion Energy	Ion Flux	Negative Ions	Temperature	Bias Voltage	Ion Angular Distribution	Ion Neutral Fraction	Deposition Rate	Ion Species (Mass)
Semion	✓	✓	✓	✓	✓				
Vertex	✓	✓	✓	✓	✓	✓			
Quantum	✓	✓			✓		✓	✓	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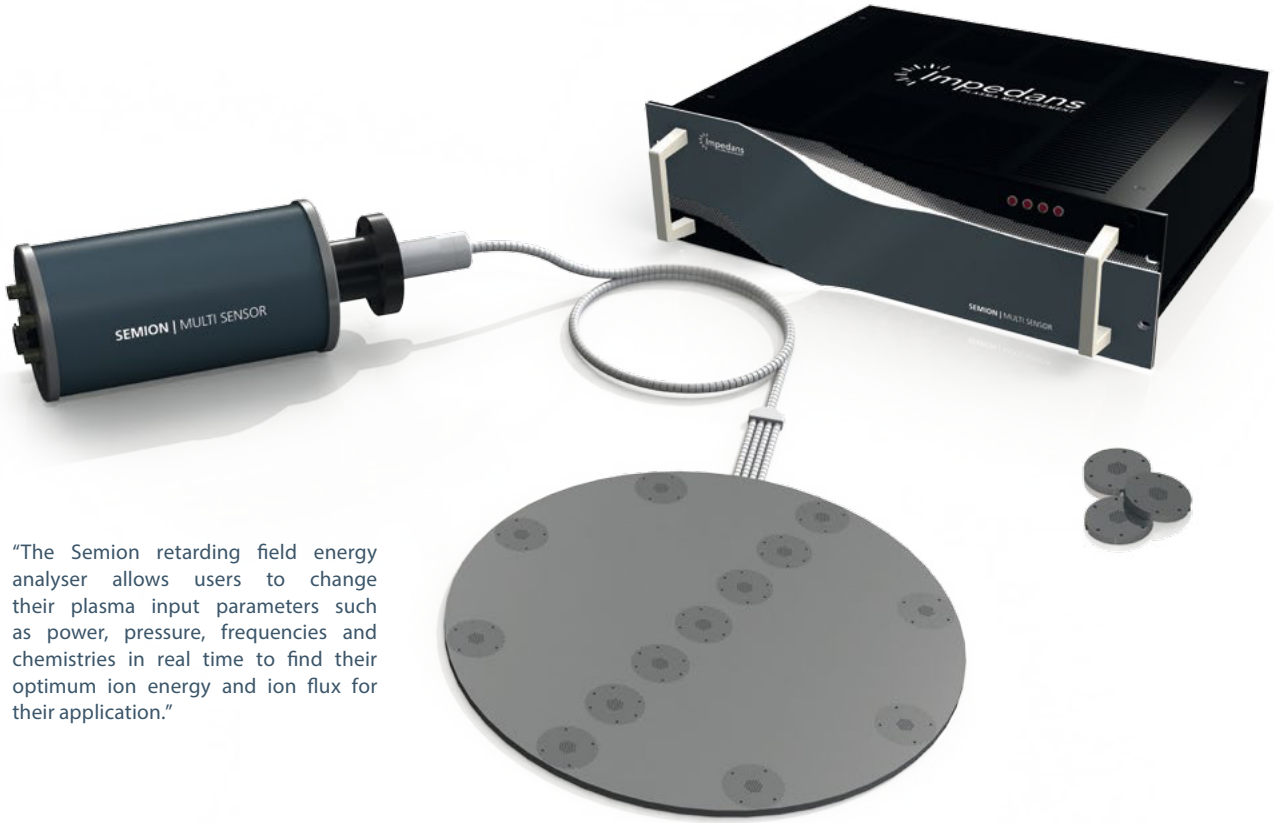
PLASMA MEASUREMENT

Semion System

Ion Energy, Ion Flux and Uniformity Analysis



"The Semion retarding field energy analyser allows users to change their plasma input parameters such as power, pressure, frequencies and chemistries in real time to find their optimum ion energy and ion flux for their application."

Measures

- Ion energy distribution
- Ion flux
- Postive / negative ions
- Average Ion Energy
- Electrode Voltage (Vdc)
- Uniformity*

Functionality

- Time averaged
- Time resolved
- Time trend

Features

- Up to 13 measurement points
- Simultaneous measurement
- Replaceable button probe sensors
- Custom sensor holder-plates
- Energy levels up to 2500eV
- User friendly software
- Fully automated system
- Easy to setup and use
- Most advanced ion energy and ion flux measurement system in the world

The Semion Multi Sensor Retarding Field Energy Analyser measures the uniformity of ion energies hitting a surface using an array of integrated sensors.

This cutting edge retarding field energy analyser also measures the uniformity of ion flux, negative ions, temperature, and bias voltage at any position inside a plasma chamber.

The Semion Multi Sensor is primarily used for researching wafer uniformity in industrial plasma applications but it also finds applications in research. Users in the semiconductor community are concerned with the uniformity of ion interactions with the substrate and this holds true for coatings, etching, plasma sputtering, PECVD and ion beam applications.

With ever increasing substrate sizes plasma uniformity becomes increasingly critical. The Semion Multi Sensor saves time and confirms plasma uniformity models, which is essential in the development of larger plasma tools.

Note: Time resolved functionality can be used when the plasma is pulsed and the Semion Sensor is mounted on a grounded or floating electrode.

Measuring Parameters	
Ion Energy	2000 - V_{dc}(eV)
Ion Current	1 mA DC max
Ion Flux Range*	
Low	0.001 to 3 (A m^2)
Standard	0.01 to 50 (A m^2)
High	0.1 to 700 (A m^2)
Low	0.01 - 20mA/cm^2
IEDF Resolution	± 1eV nominal

*Choice dependent on plasma density

Probe Bias Conditions	
Max RF Bias Voltage	1kV pk-to-pk
Max DC Bias Voltage	-1940 V
Bias Frequency Range (Time Averaged Measurements)	100kHz to 80MHz
Bias Frequency Range (Time Resolved Measurements)	0Hz to 100kHz
Time Resolution	100 µs

* For pulsed plasmas with mounted on grounded or floating electrode

RFEA Probe	
Number of Sensors	1 - 13
Probe Configuration	4-grid
Button Probe Diameter	33mm
Holder Diameter	50mm to 450mm, custom available on request
Holder Thickness	5mm
Max Operating Temperature	200°C
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and ceramic (Al_2O_3) on request
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly	
Flange Type	CF40 (custom available)

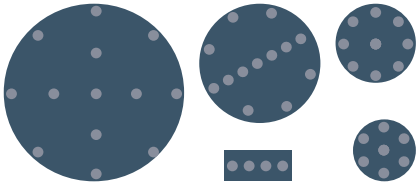
Control Unit Electronics	
Grid Voltage Range	-2 kV to 2kV
Current Range	-1mA to +1 mA
Connectivity	USB 2.0
SYNC Signal Specification	TTL (0 V to 5 V Square Wave)

Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

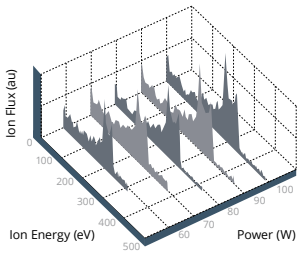
Operating Parameters	
Pressure (Pascal | Torr)	<0.1 to 40Pa | 0 to 300 mTorr*
Density Ranges (Ar at 3 eV)	
Low	1.2 x 10^{12} to 7.4 x 10^{15}
Standard	2.0 x 10^{13} to 1.2 x 10^{17}
High	2.7 x 10^{14} to 1.6 x 10^{18}

Sensor Holders

The Semion sensor holder is available in various standard sizes of 50mm, 70mm, 100mm, 150mm, 200mm, 300mm, 450mm with custom shapes also available. It sits on a grounded or biased electrode and is used to hold the replaceable button probe sensors. The holder is available in a number of materials including aluminium, anodised aluminium and stainless steel with custom materials available.

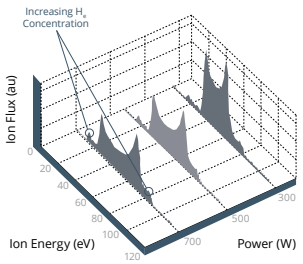


Ion Energy as a Function of Power



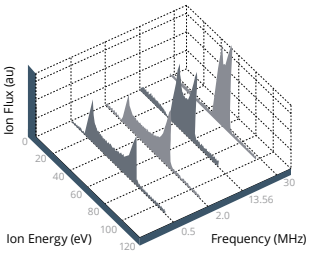
Ion Energy Distributions measured at at various power levels

Ion Energy as a Function of Chemistry



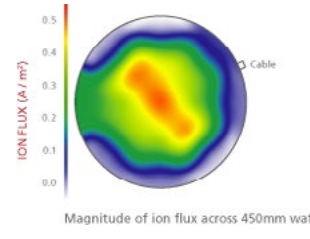
Ion Energy Distrubtions Measured for different Helium Concentrations

Ion Energy as a Function of Frequency



Ion energy distribution measured at different RF Bias Frequencies

Contour Map



Countour Map of the Ion Energy Uniformity Across the Substrate

Vertex System

Ion Energy Distribution

"By measuring the uniformity of ion angular distribution from different locations the user can identify changes in their process and troubleshoot input parameters affecting it."

Measures

- Ion energy
- Ion flux
- Negative ions
- Bias voltage

Functionality

- Time averaged
- Time trend

Features

- Vertex advanced electronics unit
- Analytical software suite
- Range of sensor holder arrays
- Replaceable button probe sensors
- Quick start and advanced user modes

The Vertex Multi Sensor measures the ion energy distrubtion as a function of aspect ratio from multiple locations across a substrate holder.

The Vertex multi Sensor is an enhanced RFEA system with spatial profiling capability as well as variable aspect ratio functionality. It is used in applications where the anisotrophy, of charged particles is crucial for feature profiling. Vertex measurements helps users confirm models and develop new processes.

The Vertex System is composed of a 19" rack mountable electronics unit, a vacuum feed-through, and a sensor holder which can be placed anywhere inside a plasma or beam chamber. It can even be mounted on an RF or DC powered electrode. The Electronics unit connects to a laptop or a PC| and uses the Vertex intelligent software suite.

The Vertex Multi Sensor analyses the change in plasma input parameters or beam source location in real time, helping users to find the optimum uniformity of ion energy distributino as a function of aspect ratio for their application. The system also takes useful measurements such as DC bias voltage and the energy and flux of negative ions.

The Vertex can be used to infer critical process information such as the level of side wall etch, beam divevergence and ion scattering. This can assist with chamber-to-chamber matching, fault detection and new processes design. For the first time, direct measurement of the energy distribution through high aspect ratio features is available with the Vertex System, helping to reduce process development time.

Measuring Parameters

Aspect Ratio Range	0.5 to 20
Aspect Ratio Resolution	0.5
Ion Energy Range	2000 eV - Vdc
Ion Current	1 mA DC max
Ion Flux Ranges*	
Low	0.001 to 3 (A m^{-2})
Standard	0.01 to 50 (A m^{-2})
High	0.1 to 700 (A m^{-2})
IEDF Resolution	± 1eV nominal

*Choice dependend on plasma density

Probe Bias Conditions

Max RF Bias Voltage	1kV pk-to-pk
Max DC Bias Voltage	-1940 V
Bias Frequency Range (Time Averaged Measurements)	100kHz to 80MHz
Bias Frequency Range (Time Resolved Measurements)	0Hz to 100kHz
Time Resolution	100 µs

*For pulsed plasma with Vertex mounted on a grounded or floating electrode in ion energy mode only

RFEA Probe

Number of Sensors	1 to 13
Probe Configuration	4-grid
Button Probe Diameter	33mm
Holder Diameter	150mm, 200mm, 300mm, 450mm and custom shapes
Holder Thickness	5mm
Max Operating Temperature	200°C
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and Al2O3
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly

Flange Type	CF40 (custom available)

Control Unit Electronics

Grid Voltage Range	-2kV to +2 kV
Current Range	100 pA to 2.4 mA
Connectivity	USB 2.0

Application Software

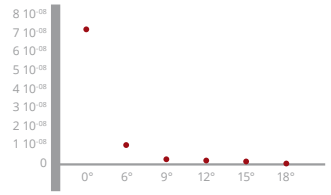
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

Operating Parameters

Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density Ranges (for Ar at 3 eV)	Low: 1.2 x 10^{12} to 7.4 x 10^{15} | Std: 2.0 x 10^{13} to 1.2 x 10^{17} | High: 2.7 x 10^{14} to 1.6 x 10^{18} (m^{-3})
Gas Reactivity	Inert to highly reactive

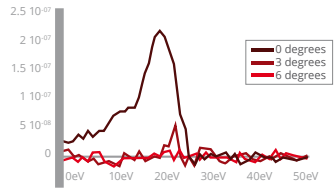
*Dependent on ion mean free path

Ion Angle Distribution



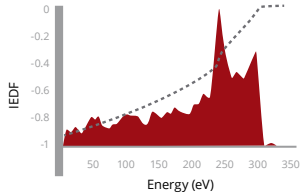
The angle of ions arriving at a range of energies can be plotted as a function of elevation angle

Ion Angle and Energy Distribution



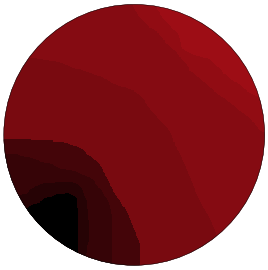
The complete ion energy distribution as a function of elevation angle in a parallel plate discharge

Ion Energy Distribution Function & Total Current



The ion energy distribution function and total current in a single location

Contour Map



Contour map showing parameters as a function of position

Quantum System

Ion Neutral Deposition Rate Monitor

"The ion flux fraction at multiple locations is now measurable. This offers our clients a unique view into their plasma process with never before seen detail."

Measures

- Ion neutral fraction
- Deposition rate
- Ion energy
- Ion flux
- Bias voltage

Functionality

- Time averaged
- Time trend

Features

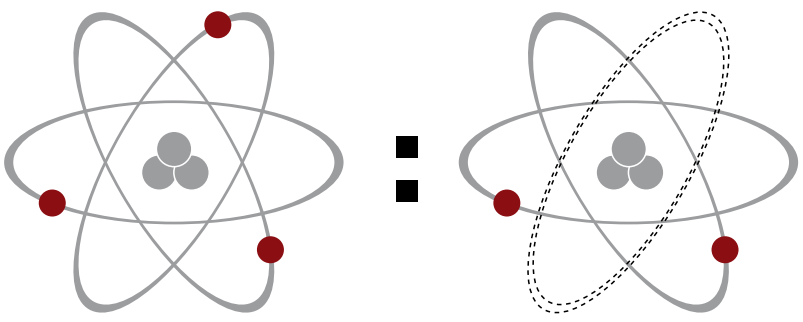
- Quantum electronics unit
- Advanced analytical software suite
- Replaceable button probe sensors
- Quick start and advanced user modes

The Quantum Multi Sensor is an energy resolving gridded quartz crystal microbalance, used to measure the ion neutral fraction hitting a surface inside a plasma reactor.

This cutting edge instrument also measures the deposition rate, ion energy, ion flux and bias voltage.

The Quantum System is used in sectors across industry and research with applications in plasma deposition, coatings, plasma sputtering, PECVD, etching and beam.

The Quantum System is perfect for users researching plasma recipes, ionization, plasma processes, tool development and fundamental plasma research.



Neutral Ion

Measuring Parameters

Ion Energy Range	2000eV - Vdc
Ion Current	2mA DC max
Ion Flux	Std: 0.01 - 50 (A/m²)
IEDF Resolution	± 1eV nominal

Crystal Monitor

Frequency Range	3.5MHz to 6.1MHz
Frequency Resolution	1 Hz
Mass Resolution (at crystal)	12.3ng/cm²
Mass Resolution (at sensor surface)	372.73ng/cm²
Film Thickness Resolution (Copper)	4Å
Measurement Update Rate	10 measurements / second

RFEA Probe

Probe Configuration	4-grid plus Quartz crystal
Button Probe Diameter	33mm
Holder Diameter	100mm (4"), 300mm (12") as standard
Holder Thickness	5mm
Max Operating Temperature	200°C
Max RF Bias Voltage	1kV pk-to-pk
Max DC Bias Voltage	-1940 V
RF Bias Frequency Range	400kHz to 80MHz
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel* and (Al2O3)*
RFEA Probe Cable Length	650mm standard (custom available)

*On request

Feed-Through Assembly

Flange Type	CF40 (custom available)

Control Unit Electronics

Grid Voltage Range	-2kV to +2 kV
Current Range	100pA to 2.4mA
Connectivity	USB 2.0

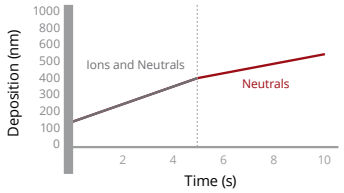
Application Software

Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

Operating Parameters

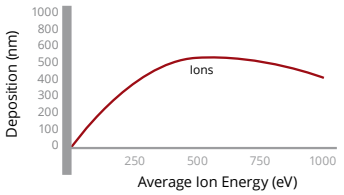
Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density	10^{12} to 10^{18} m^{-3}
Gas Reactivity	Inert to highly reactive

Deposition as a Function of Time showing Flux Fraction



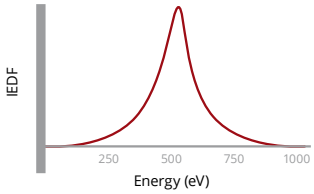
Total deposition rate versus neutral deposition rate in a plasma deposition chamber

Deposition as a Function of Average Ion Energy



Deposition as a function of increasing average ion energy hitting a substrate in a plasma deposition chamber

Ion Energy



The ion energy distribution function in a single location

Bulk Plasma Measurement

The parameters that make up the bulk of the plasma such as plasma potential, plasma density, ion density, electron energy and electron temperature can be measured giving greater understanding of the bulk plasma.

Langmuir Probe

Plasma Volume Characterisation

"The Langmuir Probe has ultra fast repeatable measurements and includes a Single and Double Langmuir Probe as standard."

Measures

- Floating potential (Single only)
- Plasma potential (Single only)
- Plasma density
- Ion current density
- Electron energy distribution function (Single Only)

Functionality

- Time averaged
- Time resolved
- Time trend

Features

- Langmuir probe automated electronics unit
- Advanced analytical software suite
- Replaceable probe head
- Quick start and advanced user modes
- Integrated air cooling
- External trigger
- DC compensation
- RF compensation

The Langmuir Probe is one of the most common and widely used plasma diagnostics and characterisation instruments to measure parameters in the bulk of the plasma. The Langmuir Probe measures plasma parameters such as floating potential, plasma potential, plasma density, ion current density, electron energy distribution function and electron temperature.

The Langmuir Probe has the most advanced technology on the market and analyses ion and electron trajectories to obtain accurate measurements of the real plasma parameters in a wide range of plasma applications. The Langmuir Probe is the fastest and most reliable Langmuir probe in the world (time resolution 12.5ns). In addition to speed and reliability, the Langmuir Probe provides the most advanced and trusted, fully automated data analysis in real time.

The Impedans Langmuir Probe system comes complete with interchangeable single and double probe tips (at no extra cost) which can be used with the same electronics unit. This allows users to conduct experiments across different reactors and allows measurements in reactors which have a poor ground return.

The Langmuir Probe is used to establish plasma process repeatability. It helps the user to understand plasma changes and the impact on surface treatment. The Langmuir Probe is an essential plasma process diagnostic to understand the correlation between plasma inputs and the plasma state. The Langmuir Probe reduces process and tool development time, as well as the time to market for new plasma products. Pulsed plasmas are used to tailor the electron or ion energy and the Langmuir Probe is an integral part of pulsed process development.

Measuring Parameters

Floating Potential	-145V to 145V
Plasma Potential	-100V to 145V
Plasma Density	10^6 to $3x10^{13}cm^{-3}$
Ion Current Density	1μA/cm² to 300mA/cm²
Electron Temperature	0.1 to 15 eV
Electron Energy Distribution Function	0 to 100eV

Langmuir Probe Specifications

Plasma Power Source	DC, RF, microwave, continuous, pulsed plasma
RF Plasma	Broadband Probe 2MHz to 100MHz
Probe Length	300mm to 1400mm (custom available)
Probe Diameter	6.5mm (custom available)
Probe Tip Length	10mm (custom available)
Probe Tip Diameter	0.4mm (custom available)
Probe Tip Material	W, Ta, Ni, Pt. (custom available)
Probe Customisation	90°, 45° bend (custom available)
Maximum Operating Temperature	230°C (custom up to 1200°C)

Linear Drive

Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	300mm, 450mm, 600mm or custom

Electronics Control Unit

Probe Voltage Scan Range	-150V to +150V
Current Range	15nA to 150mA or 1.5μA to 1A for high current densities
Communication	USB 2.0
Sampling Rate	80 MSPS (V,I)
Data Acquisition Resolution	4.5mV, 4.5nA
Time Resolved Step Resolution	12.5nS
External Trigger TTL Compatible	2 Hz to 500 MHz

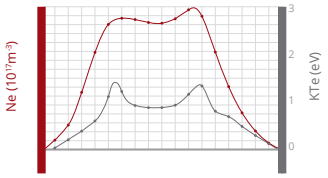
Operating Parameters

Pressure (Pascal)	0 to 1,000Pa
Pressure (Torr) | Single Probe	0 to 10Torr
Pressure (Torr) | Double Probe	0 to 760Torr
Gas Temperature	20° to 1000°
Density	10^4cm^{-3} to $10^{14}cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	DC (0kHz) • pDC (0 to 350kHz) • MF (0 to 1MHz) • RF (1MHz to 100MHz) • Microwave (1GHz to 3 GHz)

Application Software

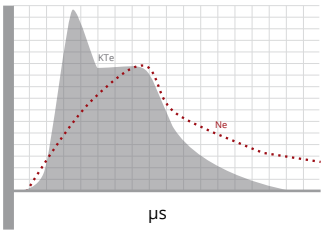
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

Spatial Resolution



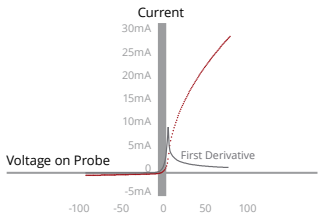
Spatial distribution of electron density and energy in a 150mm chamber

Time Resolution



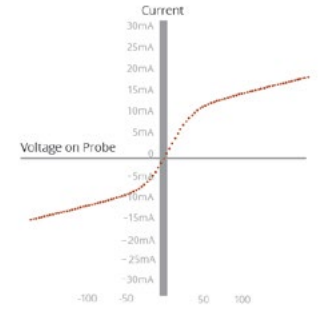
The electron energy and density in a micro-second pulse

Single Probe Trace



The current as a function of probe voltage in a plasma. The first derivative peaks at the plasma potential. All parameters are calculated automatically.

Double Probe Trace



The current as a function of probe voltage in a plasma. All parameters are calculated automatically.

Plato Probe

Deposition Tolerant Plasma Measurement System

"It is now possible to measure the uniformity of plasma parameters in a plasma depositing an insulating layer."

Measures
- Plasma density
- Ion current density
- Electron temperature

Functionality
- Time averaged
- Time resolved
- Time trend

Features
- Fully automated electronics and software
- Reactive process compatible probe tips
- External trigger
- DC compensation
- RF compensation

The Plato Probe is planar Langmuir Probe designed to work in deposition plasmas when an insulating film is deposited on the probe surface. This deposition tolerant Langmuir probe can remain inside a plasma reactor while deposition processes are in progress.

The Plato Probe measures plasma parameters such as plasma density, ion current density and electron temperature in plasmas with high deposition rates, like plasma enhanced chemical vapour deposition (PECVD).

The Plato Probe has the most advanced patented technology on the market using ultra-fast biasing to penetrate the deposited film to obtain accurate measurements of the real plasma parameters in a wide range of plasma applications.

For many years it has been difficult to measure the parameters of plasma in high deposition environments. Impedans have developed a ground-breaking technology which measures the parameters of plasma, even when a thick insulating layer is deposited on the probe surface.

Measuring Parameters

Plasma Density	$1x10^6$ to $3x10^{13}cm^{-3}$
Ion Current Density	$1\mu A/cm^2$ to $300mA/cm^2$
Electron Temperature	0.1 to 15 eV

Plato Probe Specifications

Plasma Power Source	DC, RF, microwave, continuous, pulsed plasma
RF Plasma	13.56 MHz to 100 MHz
Probe Length	300mm to 1400mm (custom available)
Probe Diameter	9.5mm
Probe Tip Diameter	7mm
Probe Customisation	On request
Maximum Operating Temperature	230°C

Linear Drive

Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	300mm, 450mm, 600mm or custom

Electronics Control Unit

Probe Voltage Scan Range	Floating potential ±30V
Current Range	100nA to 20mA
Communication	USB 2.0
Sampling Rate	80 MSPS (V,I)
Data Acquisition Resolution	4.5mV, 4.5nA
Time Resolved Step Resolution	1µS to 1mS
External Trigger TTL Compatible	10Hz to 50KHz

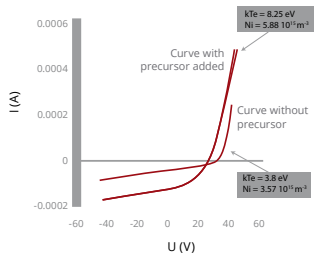
Application Software

Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

Operating Parameters

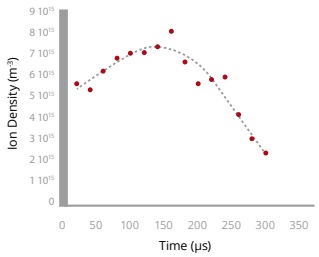
Pressure (Pascal)	<0.1 to 1,000Pa
Pressure (Torr)	< 1 mTorr to 10 Torr
Density	10^6cm^{-3} to $10^{14}cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	DC (0 to 50kHz) • RF (2MHz to 100MHz) • UHF (100MHz to 1GHz) • Microwave (1GHz to 3 GHz)

Plato Probe Measurements



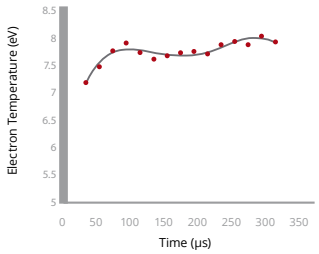
Current and voltage characteristic with and without depositing precursor

Time Resolved Ion Density



Time resolved ion density in a pulsed deposition plasma

Time Resolved Electron Temperature



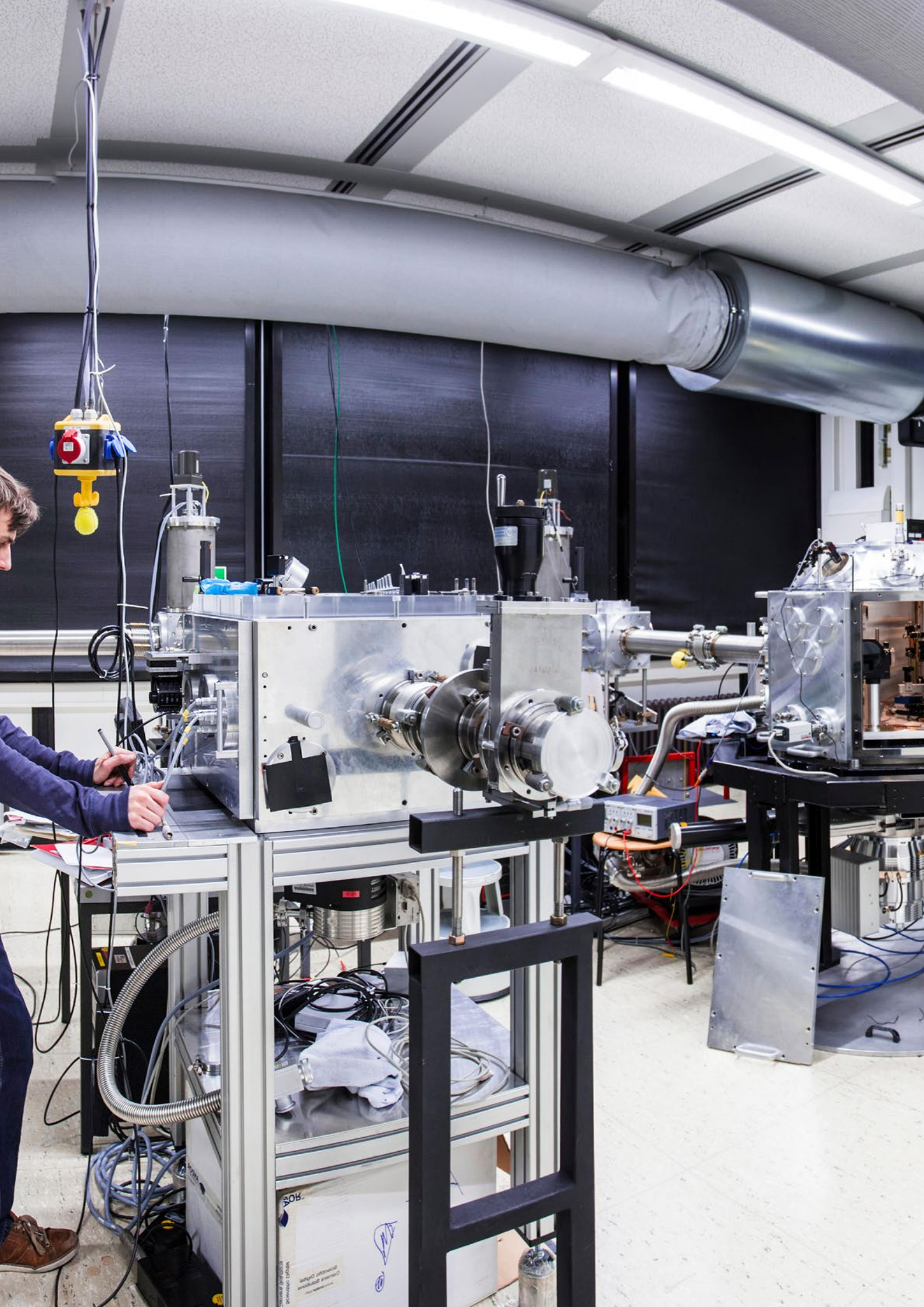
Time resolved electron temperature in a pulsed deposition plasma

Power Delivery Plasma Monitoring & Fault Detection

Slight changes in power, as a plasma input parameter, can affect the quality of a substrate. Monitoring the voltage, current, phase and harmonic information can result in better process stability.

Octiv System Comparison Chart

	Real Power	Forward Power	Reflected Power	Impedance	Voltage	Current	Phase Angle	Harmonics	Simultaneous Measurements	Ion Flux	Waveform Reconstruction
Mono	✓	✓	✓	✓							
VI	✓	✓	✓	✓	✓	✓	✓	✓			
Poly	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Suite	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓



OCTIV Poly VI Probe

Multi Frequency In-Line RF Voltage, Current, Phase, Impedance & Harmonic Measurement System

" The Octiv Poly system allows users to measure a number of fundamental frequencies and extract all of the harmonic information of each parameter measured simultaneously. "

Measures
- Voltage
- Current
- Phase
- Harmonics
- Impedance

Functionality
- Time averaged
- Time resolved
- Time trend
- Smith chart

Features
- Interchangeable connectors
- Compact probe design
- Frequency agile software
- API for extending software
- USB 2.0 communications interface as standard

The Octiv Poly VI Probe is used to monitor the radio-frequency (RF) characteristics of your plasma processing equipment. Applications include fault detection and classification, chamber-to-chamber matching and process fingerprinting. Successful implementation helps to improve production yield, increase product throughput and reduce product scrappage.

The RF characteristics of the process can be correlated to process performance i.e. reference baselines can be established and fault signatures can be identified. The sensor monitors a wide range of RF parameters, suitable for use in multivariate analyse is techniques which provide extremely sensitive fault detection and classification algorithms. It enables indirect measurement of plasma parameters, helping you to understand and control the process. The Octiv Poly helps to define exact process windows and determine the health of power subsystems and process run-to-run stability.

For pulsed RF applications it has 1 µs time resolution for pulse profiling. The Octiv Poly VI Probe is ideal for accurately monitoring dual frequency and triple frequency plasma systems.

Measuring Parameters (Range)w	
Voltage Range	Voltage 20 – 3000 Vrms
Current Range	0.1 – 20 Arms
Phase Range	± 180°
Harmonic (Voltage, Current and Phase)	Up to 15 harmonics per frequency
Frequency Range	350 kHz - 300 MHz
Fundamental Frequencies	5 simultaneous
Power Real, Forward and Reflected (Watt)	200 mW to 12 kW (23 dBm to 70.8 dBm)*
Power Real, Forward and Reflected (dBm)	25 dBm to 70 dBm
Impedance	1 to 500 Ω

Pulse Parameters (Time)	
Voltage Time	1 µs
Current Time	1 µs
Phase Time	1 µs
Frequency Time	1 µs
Impedance Time	1 µs
Power Real, Forward and Reflected (Watt) Time	1 µs
Power Real, Forward and Reflected (dBm) Time	1µs

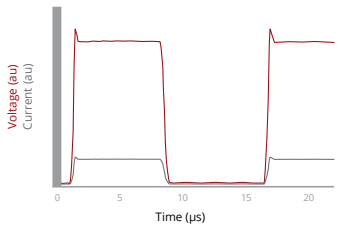
Measuring Parameters (Accuracy)	
Voltage Accuracy	± 1%
Phase Accuracy	± 1°
Harmonic (Voltage, Current and Phase) Accuracy	± 5%
Frequency Accuracy	± 10 kHz
Impedance	± 1%
Power Real, Forward and Reflected (Watt/dBm)*	± 1%

Measuring Parameters (Resolution)	
Voltage Resolution	0.25 V
Phase Resolution	0.01°
Harmonic (Voltage, Current and Phase) Resolution	As above
Frequency Resolution	1 kHz
Impedance Resolution	± 1%
Power Real, Forward and Reflected (Watt/dBm) Resolution	± 1%

Sensor Specifications	
Number of fundamentals	(F0) Maximum of 5 simultaneously
RF Power	Max 12.5 kW (limited by connector)
Operating Temperature	0 to +40° C (32 to 104° F)
Storage Temperature	-20 to +80° C (-4 to +176° F)
Uniformity	2% Maximum
Connectors	N, HN. 7/16's, LC (Custom available on request)
Sensor Impedance	50Ω
Certification	CE mark
Calibration Cycle	12 Months

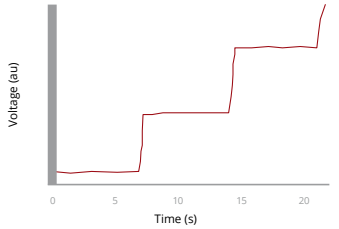
Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10

Pulsed Profile



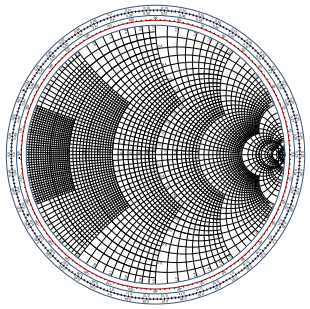
Time resolved pulsed RF Profile

Voltage Step



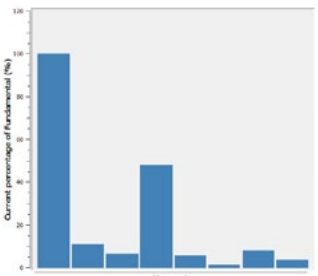
RF Voltage Ramp Versus Time

Smith Chart



Smith Chart Impedance Matching

Harmonic Spectrum



Single RF Frequency Harmonic Spectrum

Octiv Suite

Multi-Frequency RF System with Plasma Diagnostic and Complex Waveform Analysis

"The Octiv Suite RF diagnostic system allows users to measure a number of fundamental frequencies and extract all the harmonic information of each parameter, measured simultaneously while reconstructing multiple waveforms."

Measures
- Voltage
- Current
- Phase
- Harmonics
- Impedance
- Ion flux
- Waveform reconstruction

Functionality
- Time averaged
- Time resolved
- Time trend
- Smith chart

Features
- Interchangeable connectors
- Compact probe design
- Frequency agile software
- API for extending software
- USB 2.0 as standard

The Octiv Suite RF diagnostic is an in-line RF voltage, current, phase, harmonics and plasma diagnostic system. It can measure all the parameters of RF power, break them down to their individual components and reconstruct the waveforms of multiple fundamental frequencies simultaneously.

This cutting edge system can also measure plasma parameters such as ion flux by using the RF electrode as a sensor. The Octiv Suite is truly in a class of its own when it comes to analysing power delivery into a plasma reactor. The Octiv Suite measures voltage, current, phase, impedance and harmonics and the measurements can be viewed from a PC or direct on the optional meter unit.

Measuring Parameters (Range)

Voltage Range	Voltage 20 – 3000 Vrms
Current Range	0.1 – 20 Arms
Phase Range	± 180°
Harmonic (Voltage, Current and Phase)	Up to 15 harmonics
Frequency Range	350 kHz – 300 MHz
Fundamental Frequencies	5 simultaneous
Impedance	1 to 500Ω
Power Real, Forward and Reflected (Watt)	200mW to 12KW
Power Real, Forward and Reflected (Watt)	23 dBm to 70.8 dBm

Measuring Plasma Parameters

Ion Flux (based on 300mm electrode)	1 A/m² to 100 A/m²
Plasma Resistance	1 to 500Ω
Non Linear Sheath Impedance	0.1 to 500Ω

Pulsed Parameters (Time)

Voltage, Current, Phase	1µs
Harmonic (Voltage, Current and Phase)	1µs
Frequency and Impedance	1µs
Power Real, Forward and Reflected (Watt)	1µs

Measuring Parameters (Accuracy)

Voltage and Current Accuracy	± 1%
Phase Accuracy	± 1°
Harmonic (Voltage, Current and Phase) Accuracy	± 5%
Frequency Accuracy	± 10kHz
Impedance	± 1%
Power Real, Forward and Reflected (Watt)	± 1%
Power Real, Forward and Reflected (dBm	± 1%

Measuring Parameters (Resolution)

Voltage Resolution	0.25V
Current Resolution	10mA
Phase Resolution	0.01°
Harmonic (Voltage, Current and Phase) Resolution	As above
Frequency Resolution	1kHz
Impedance Resolution	± 1%
Power Real, Forward and Reflected (Watt) Resolution	± 1%
Power Real, Forward and Reflected (dBm) Resolution	± 1%

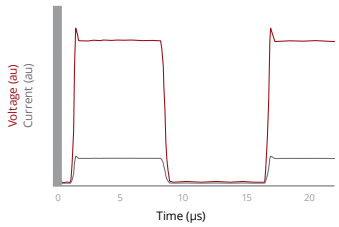
Sensor Specifications

Number of fundamentals (F	(F0) Maximum of 5 simultaneously
RF Power Max 12.5 kW	Max 12.5kW (limited by connector)
Operating Temperature	0 to +40° C (32 to 104° F)
Storage Temperature	-20 to +80° C (-4 to +176° F)
Uniformity	2% Maximum
Harmonic Content	Measured (No Limit within Range)
Connectors	All Standard Connectors Available
Sensor Impedance	50 Ω
Certification	CE mark
Calibration Cycle	12 Months

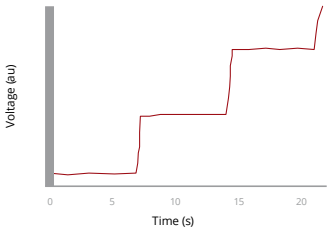
Operating Parameters

Impedance	0Ω to 5,000Ω
Pulsed Repetition Frequency	10Hz to 100KHz
Voltage	20V to 3,000V
Current	0.1A to 100A
Phase	±90°, ±180°
Power Frequency	MF (350kHz to 1MHz) • RF (1MHz to 100MHz)

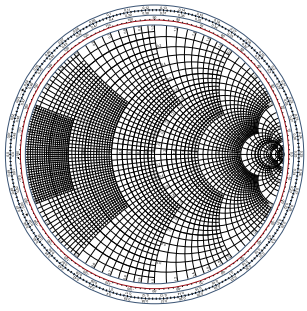
Pulsed Time Resolution



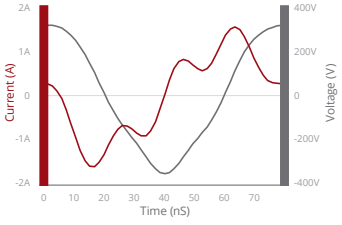
Voltage Step



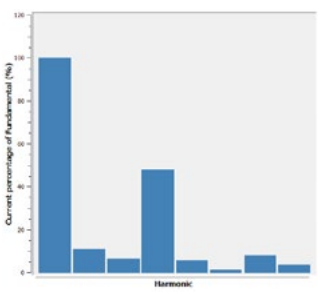
Smith Chart



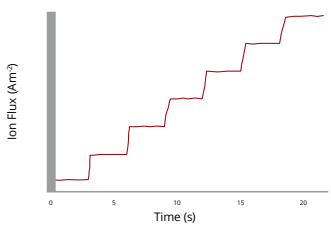
Waveform Reconstruction



Harmonic Spectrum



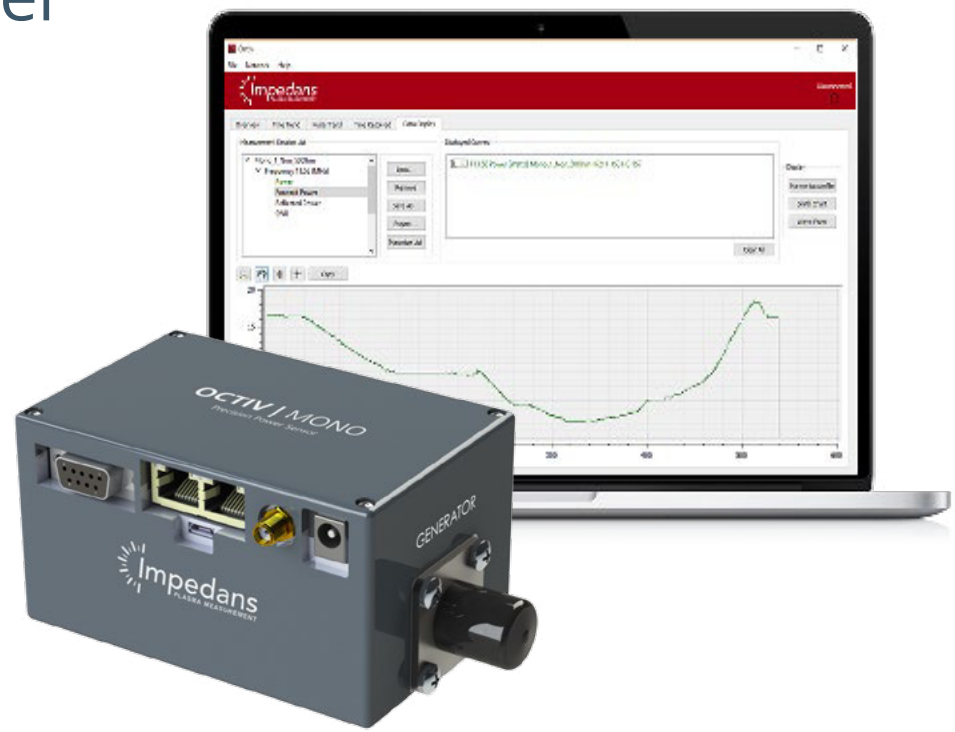
Ion Flux Time Trend



Octiv Mono

RF Wattmeter

"The Octiv Mono RF power meter and RF power sensor can measure up to five different fundamental frequencies in a single sensor. This reduces the need for multiple sensors in a laboratory environment."



Measures

- Real power
- Forward power
- Reflected power
- Impedance

Functionality

- Time averaged
- Time resolved
- Time trend
- Smith chart

Features

- Octiv VI meter display unit
- Compact probe design
- Frequency agile software
- Application Programming Interface (API) for extending software
- USB 2.0 communications interface as standard with RS-232 and Ethernet available on request

The Octiv Mono is an in-line RF power meter and RF power sensor measurement system. It measures a single fundamental frequency and has an accuracy rating of 1% and a time resolution of 1µs. Each system has a drop down menu with a choice of 5 fundamental frequencies. It measures real power, forward power, reflected power, impedance and displays through a meter unit.

The Octiv Mono is a precision RF power sensor used in a large number of laboratory applications. The Octiv Mono operates to 1% true accuracy, and is immune to harmonics. It measures true power into any load, including a non-50Ω cable or load, making it the most trusted power sensor for applications such as semiconductor manufacturing.

The Octiv Mono is calibrated to five fundamental frequencies: 2MHz | 13.56MHz | 27.12MHz | 40.68MHz | 60MHz. Each frequency can be selected via a drop down menu and the sensor has a power range from 0 to 12 kW.

The Octiv Mono RF power meter and RF power sensor helps solve issues such as poor production yields, tool matching, fault detection and classification. It helps to define exact process windows and determines the health of power subsystems. The Octiv Mono helps determine 'process run to run' stability. It gives you the confidence to trust the accuracy of the most complex process input, RF power delivery.

Measuring Parameters

Power Real (Watt)	200 mW to 12 KW
Power Forward (Watt)	200 mW to 12 KW
Power Reflected (Watt)	200 mW to 12 KW
Power Real (dBm)	25 dBm to 70 dBm
Power Forward (dBm)	25 dBm to 70 dBm
Power Reflected (dBm)	25 dBm to 70 dBm
Impedance	1 to 500 Ω

Sensor Performance

Accuracy	± 1% (at frequencies and power defined)
Number of Frequencies	5 interchangeable
Frequency Range	350 kHz to 100 MHz
Uniformity	2% Maximum
Speed	10 Readings per Second
Maximum Power	12 kW
Harmonic Interference	No Limit (Within Power Range)
Directivity	38 dB
Sensor Impedance	50 Ω

Sensor Specifications

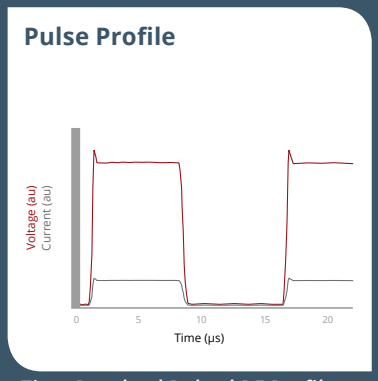
Connectors	All Standard Connectors Available
Power Requirements	USB or From Display Unit
Dimensions	70 mm x 70 mm x 55 mm
Weight	400 g
Operating Temperature	0°C to 35°C
Storage Temperature	-40°C to 80°C
Humidity	95% Max (non-condensing)
Altitude	3000 m
Certification	CE mark
Calibration Cycle	12 Months

Operating Parameters

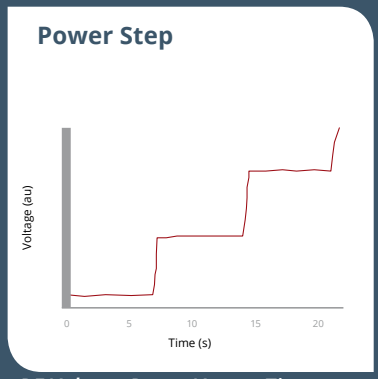
Impedance	50 Ω
dBm	20 dBm to 70 dBm
Power	10 W to 10 kW
Power Frequency	MF (350 kHz to 1 MHz) • RF (1 MHz to 100 MHz)

Application Software

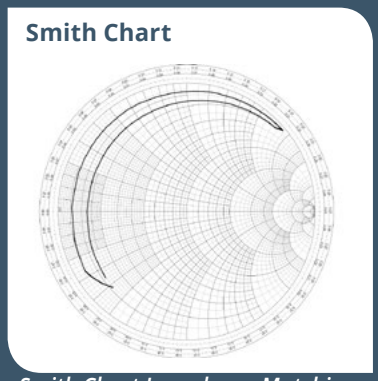
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10



Time Resolved Pulsed RF Profile



RF Voltage Ramp Versus Time



Smith Chart Impedance Matching

INDUSTRIAL | OCTIV

VI Probe Technology

Measures
- Voltage
- Current
- Phase
- Harmonics
- Impedance

Functionality
- Time averaged
- Pulse profile
- Pulse trend

Features
- 1 x USB, 1 x serial & 2 x RJ45 Ethernet ports
- Can communicate through any TCP/IP network
- API enables communication with device using LabVIEW, C/ C++, Visual Basic (VB_ and C # through .NET framework

The Octiv VI probe is an advanced and versatile radio-frequency (RF) voltage and current sensor. It can be used in a variety of installation environments and has a wide range of applications. It sees widespread deployment on RF processing equipment used in the semiconductor (and related industries) and in the medical device market.

The industrial Octiv is the first device of its type to address the needs of the industrial customer, in terms of communication standards.

The Octiv is a fully enabled internet network node that paves the way for monitoring and control of automated industrial plasma and/or RF processes in real-time to increase efficiency in ways impossible until now.

Measuring Parameters (Range)

Voltage Range	Voltage 20 – 3000 Vrms
Current Range	0.1 – 100 Arms
Phase Range	± 180°
Harmonic (Voltage, Current and Phase)	Up to 15 harmonics per frequency
Frequency Range	350 kHz - 100 MHz
Fundamental Frequencies	5 simultaneous
Power Real, Forward and Reflected	200 mW to 12 kW (23 dBm to 70.8 dBm)*
Impedance	N/A

*Connector dependent

Pulse Parameters (Time)

Pulse Repetition Frequency (SYNC)	10 Hz to 100 kHz
Voltage Time	1 µs
Current Time	1 µs
Phase Time	1 µs
Harmonic (Voltage, Current and Phase) Time	1 µs
Frequency Time	1 µs
Impedance Time	1 µs
Power Real, Forward and Reflected Time	1 µs

Measuring Parameters (Accuracy)

Voltage Accuracy	± 1%
Current Accuracy	± 1°
Phase Accuracy	± 1°
Harmonic (Voltage, Current and Phase) Accuracy	± 5%
Frequency Accuracy	± 10 kHz
Impedance	± 1%
Power Real, Forward and Reflected (Watt)*	± 1%

*depending on V,I Ø

Measuring Parameters (Resolution)

Voltage Resolution	0.25 V
Current Resolution	10 mA
Phase Resolution	0.01°
Harmonic (Voltage, Current and Phase) Resolution	As above
Frequency Resolution	1 kHz

Sensor Specifications

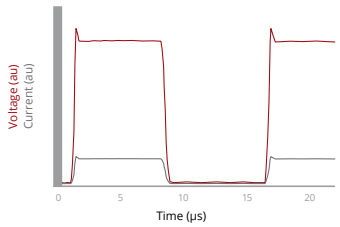
Connectors	N, HN. 7/16's, LC (custom available on request)
Number of Fundamentals	(F0) Maximum of 5 simultaneously
RF Power	Max 12 kW (limited by connector)
Power Requirements	USB
Dimensions	70 mm x 70 mm x 55 mm
Operating Temperature	0 to +55° C
Storage Temperature	-20 to +80° C (-4 to +176° F)
Humidity	95% Max (non-condensing)
Uniformity	2% Maximum
Sensor Impedance	50 Ω
Certification	CE mark
Calibration Cycle	12 Months

Application Software

Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10
Connectivity	Ethernet Web Service Protocol*

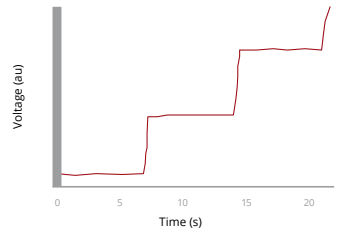
*EtherNet/IP and EtherCAT available on request

Pulse Profile



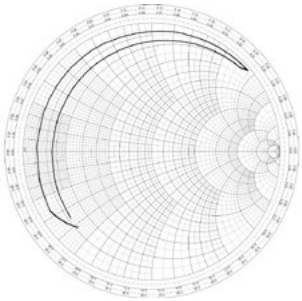
Time Resolved Pulsed RF Profile

Voltage Step



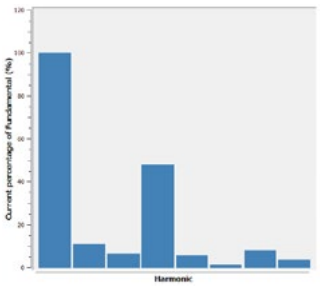
RF Voltage Ramp Versus Time

Smith Chart



Smith Chart of Impedance Matching Range

Harmonic Spectrum



Single RF Frequency Harmonic Spectrum

ALFVEN | 100

RF Event Detector

Measures

- RF voltage amplitude
- RF current amplitude
- Pulse Monitoring

Functionality

- Captures RF events with micro-second resolution
- RF strike event capture
- RF event classification
- Capturing of events can be user-defined
- Averaged values reported up to 10 times a second
- Up to 5,000 events and 500,000 averaged values can be stored on-board the sensor later.

Features

- 50 Ω characteristic impedance
- Designed for pre-match installation
- RF voltage and current event detection with 1 µs time resolution
- Interchangeable connectors
- Compact probe design
- Network API for software integration

The Alfven | 100 RF Event Detector is designed to monitor short-lived, unexpected events in radio frequency and plasma processes, that can cause product scrappage and significant cost to the manufacturer.

The Alfven | 100 RF Event Detector application runs on our best-in-class VI probe technology platform. It monitors events such as arcs, ignition phenomena and instabilities, in plasma and other RF processes, with 1 µs resolution. It detects events in both the voltage and current signals.

Our intelligent sensing platform is fully web enabled. Use one of the Ethernet ports to connect to a PC to run our proprietary application software. For a fully connected solution, interface with the process tool or the factory host through the Ethernet connection. Industrial protocols such as Ethernet/IP and EtherCAT are supported.

Plasma processes, in semiconductor (and related industries), such as plasma etching, PVD and PECVD are susceptible to events such as arcs, instabilities and ignition phenomena. The Alfven | 100 will detect these events and send real time information to the operator to enable corrective action.

Measured Parameters (Range)	
Voltage	10 V - 1,500 V_{rms}
Current	0.1 - 15 A_{rms}

Sensor Specifications	
RF Power	Maximum 11.25 kW (Higher possible with custom connectors)
Operating Temperature	0° to +40° C (32° to 104° F)
Storage Temperature	-20° to +80° C (-4° to +176° F)
Connectors	N, HN, 7/16's, LC, (Custom available on request)
Sensor Impedance	50 Ω
Certification	CE mark
Recommended Install	Pre-match 50 Ω side

Input Signal	
Voltage	Maximum Voltage 1,500 V_{rms}
Current	Maximum 15 A_{rms}
Frequency	13.56 MHz
Voltage Accuracy	10%
Current Accuracy	10%

Acquisition Speed	
Time Resolution	1 µs

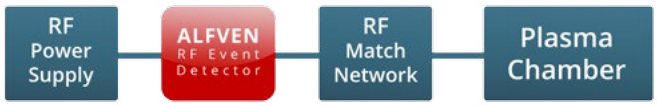
Transient Sensitivity	
Voltage	1% or 1 V (use highest) @ 1 µs
Current	1% or 15 mA (use highest) @ 1 µs

Event Capture	
Parameters	V, I
Points	Up to 5,000 pts (5 ms)

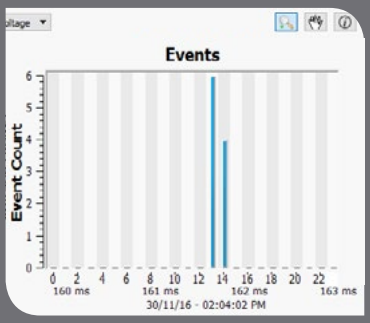
Onboard Storage	
Number of hours average V and I data	14 to 276 hours
Number of Events	5,000

Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8 / Windows 10
Connectivity	Ethernet Web Service Protocol*

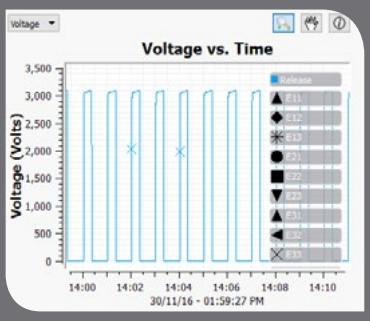
**EtherNet/IP and EtherCAT available on request*



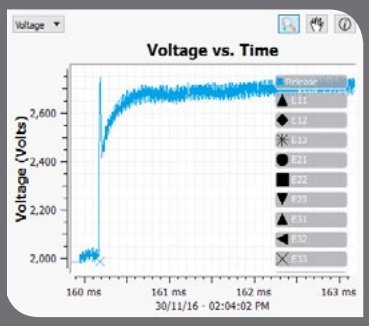
Schematic of the install location of the Alfven | RF 100 Event Detector.



Example of Event Count display over a monthly period.

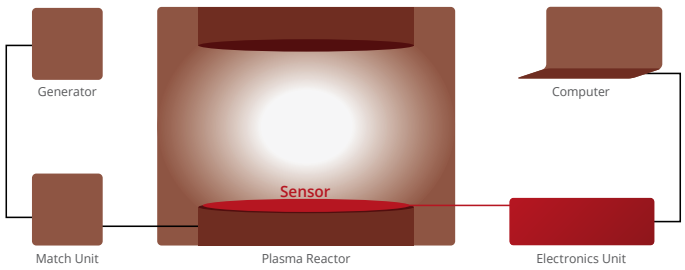


Voltage amplitude at 100 ms intervals for hourly session.

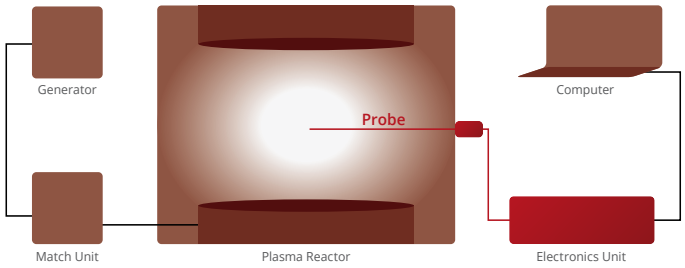


Voltage at 1 µs intervals for duration of an event .

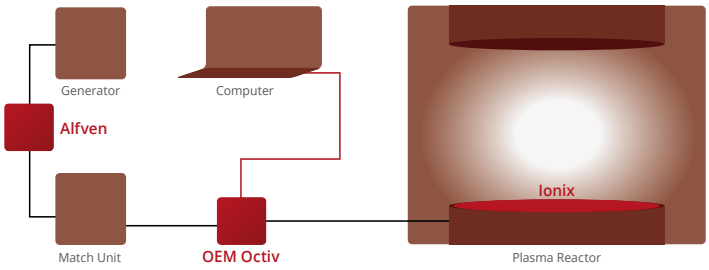
Substrate Level Ion Measurements



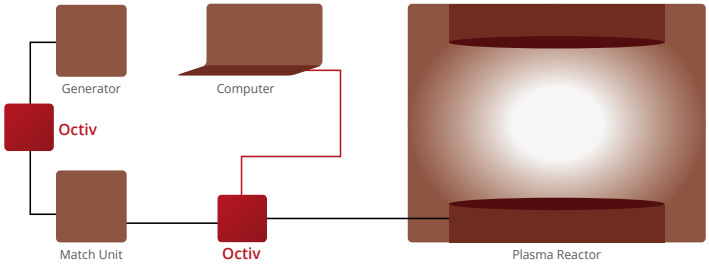
Bulk Plasma Parameter Measurements



Plasma Process Monitoring



RF Plasma Power Measurement



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Semion | Vertex

Ion Energy Analyser
Ion Energy | Ion Energy Distribution | Ion Flux
Positive/Negative Ion | Electrode Voltage
Ion Aspect Ratio (Vertex)

Applications
Dusty | Etch | HiPIMS
Ion Beam | PECVD | Space
Sputtering

Quantum

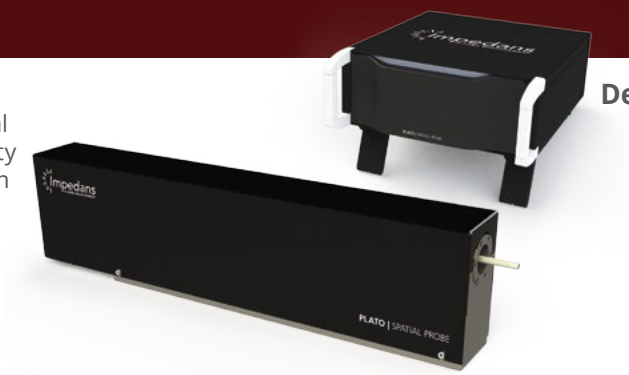
Ion Flux Fraction
Deposition Rate | Ion Energy
Ion Flux
Electrode Voltage

Applications
Dusty | Etch | HiPIMS
Ion Beam | PECVD | Space
Sputtering

Langmuir

Plasma Parameters
Plasma Potential | Floating Potential
Ion Current Density | Plasma Density
Electron Energy Distribution Function

Applications
Dusty | Etch | HiPIMS
PECVD | Space | Sputtering



Plato

Deposition Tolerant Probe
Plasma Density
Ion Current Density
Electron Temperature

Applications
Dusty | Etch | HiPIMS
PECVD | Space | Sputtering

OEM Octiv

Integrated VI Probe
Voltage | Current | Phase
Impedance | Harmonics
Ethernet | EtherCAT

Applications
Etch | Deposition | Medical
RF Heating | Plasma Power Applications

Alfven

Plasma Arc Detector
Voltage | Current
Pulse Monitoring
Microarcs

Applications
Etch | Deposition | Medical
RF Heating | Sterilisation | PECVD

Ionix

Wireless Ion Measurement
Average Ion Energy
Ion Flux
IEDF

Applications
Etch | PECVD
Ion Beam | Sputtering

Octiv Mono

Impedance RF Power Sensor
Forward Power | Reflected Power
Impedance
Smith Chart

Applications
Atmospheric | Dusty
Etching | PECVD | Space
Sputtering

Octiv Poly

VI Probe
Voltage | Current | Phase
Impedance | Harmonics
Pulsed Capability

Applications
Atmospheric | Dusty
Etching | PECVD | Space
Sputtering

Octiv Suite

VI Probe
Voltage | Current | Phase
Impedance | Harmonics | Ion Flux
Waveform Reproduction

Applications
Atmospheric | Dusty
Etching | PECVD | Space
Sputtering

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