



Moduli™ RF Spectrometer

Non-invasive Plasma Harmonic Analyser

For advanced RF plasma measurement and control applications

The RF Spectrometer is a radio-frequency (RF) detector that directly monitors the harmonics emitted by a plasma from outside the plasma chamber. This is designed for endpoint detection and fault detection on production tools without the need for an in-line sensor in the RF path. It has demonstrated superior performance to optical techniques for low open area endpoint applications. It has also been proven to detect air leaks, wafer displacement and other serious plasma faults. Simply mount the RF antenna either on the viewport, a matchbox fan or through the matchbox wall to start process characterisation.

Key Features



Choice of 5 arbitrary fundamental frequencies on a single sensor with up to 15 harmonics at each frequency.



Fully compatible with Pulsed RF, with live pulse frequency/duty cycle monitoring and a "time resolved" mode for 1 microsecond resolution pulse snapshots.



Completely non-invasive, no tool modifications are required to add this powerful diagnostic.



Multiple antenna options for different chamber types, including a novel opto-RF sensor to enable harmonic monitoring if a line-of-sight to the plasma is available.



Frequency tracking to $\pm 10\%$ of the fundamental frequency as standard, customisable for intermodulation frequency monitoring.



USB, Ethernet, EtherCAT and Serial communication protocols with easy-to-use APIs for tool/FDC integration.

Key Benefits & Applications



Clean and etch endpoint capabilities with Plasma Impedance Monitoring (PIM) and harmonic spectrum techniques.



Demonstrated to measure etch endpoint for $< 1\%$ open area ratio, with significantly sensitivity when compared to multivariate OES endpoint detectors.



Detects wafer placement issues, air leaks, cross-process contamination, and many other common plasma faults.



Gauges overall chamber health, removing the need for unnecessary preventative maintenance actions.



Significant cost benefits through the enablement of fault detection and early intervention.



These advanced applications can be achieved rapidly using the "Impedans Expert" software package and with assistance from Impedans applications team.



Model Specifications

Model #	Part	Frequency Range	Notes
02-0260-01	Acquisition Unit	350 kHz - 500 MHz	Compatible with all antennas
02-0255-01	Acquisition Unit	40 kHz - 2 MHz	Compatible with all antennas
02-0330-01	Optical Antenna	40 kHz - 500 MHz	Optical fibre adaptor on request
02-0494-01	RF Antenna - 1x	40 kHz - 500 MHz	E and B Channel with phases
02-0495-01	RF Antenna - 100x	40 kHz - 60 MHz	B Channel with harmonic phase only

General Specifications

Antenna Power	5 Vdc, 4.1 mm jack
Antenna Form Factor	[40 mm x 40 mm x 40 mm] & custom
Antenna Communication	2 x SMA coaxial cables
Acquisition Unit Power Requirements	24 Vdc, 0.5 A, 4.1 mm jack
Acquisition Unit Interfaces	Micro USB, Serial, Ethernet
Acquisition Unit Protocols	USB, HTTP Web Service, EtherCAT, Ethernet/IP Others on request
Acquisition Unit Form Factor	[122 mm x 70 mm x 41 mm]
Connectivity (Impedans Software)	USB 2.0, Ethernet
Communication Protocols (Standard)	USB 2.0, HTTP Web Service
Communication Protocols (OEM Options)	EtherCAT, EtherNet/IP, Serial, RS232
Parameter Report Rate (Standard)	Adjustable; USB up to 500 S/s, Ethernet up to 100 S/s
Acquisition Unit Pulse Synchronisation	External sync: TTL input Internal sync: Software level trigger

Measurement Parameter Specifications

# Fundamental Frequencies (F_0)	Choose 5 from the fundamental frequency range
Fundamental Frequency Range	350 kHz - 100 MHz or 40 kHz - 400 kHz
Harmonic Frequency (F_N) Range	350 kHz - 500 MHz or 40 kHz - 2 MHz
# Harmonic Frequencies (F_N)	≤ 15 per fundamental (64 max.), ≤ 32 simultaneously
Output Parameters at each frequency	V & I [UNCALIBRATED], phase, harmonic phase
Pulsed RF Profiling	1 microsecond resolution
In-Pulse Parameter Monitoring	Up to 2 points in the pulse [standard software], arbitrary number of points using API
Pulsed RF Range	10 Hz to 100 kHz
Extra Features	RF Waveform Reconstruction
V channel range	Arbitrary [adjustable gain]
I channel range	Arbitrary [adjustable gain]
Phase Range and Resolution [Available only when V & I channel are locked]	+/-180 degrees with 0.02 degrees resolution
Harmonic Phase Range and Resolution	+/-180 degrees with 0.02 degrees resolution

Demonstrated Applications

Clean Endpoint Detection	Etch Endpoint Detection
Wafer Misplacement Detection	Plasma Impedance Monitoring (PIM)
Air Leak and Gas Contamination Detection	Process-to-process repeatability monitoring
Hardware Degradation Detection	Match box failure and more



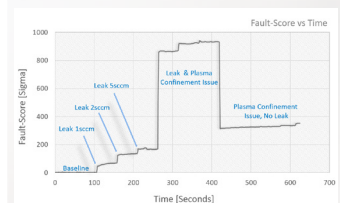
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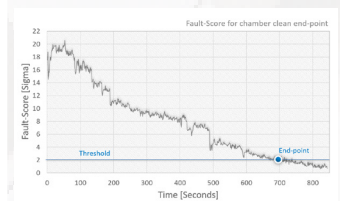
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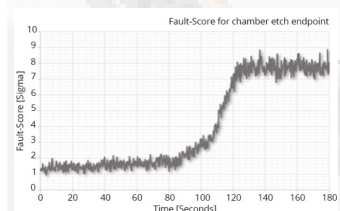
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Leak Detection with
Fault Score



Fault Score for
Chamber Clean Endpoint



Fault Score for
Chamber Etch Endpoint