Alfven | 100 RF Event Detector
PRECISION RF PULSE MONITOR AND ARC DETECTOR

Impedans
PLASMA MEASUREMENT
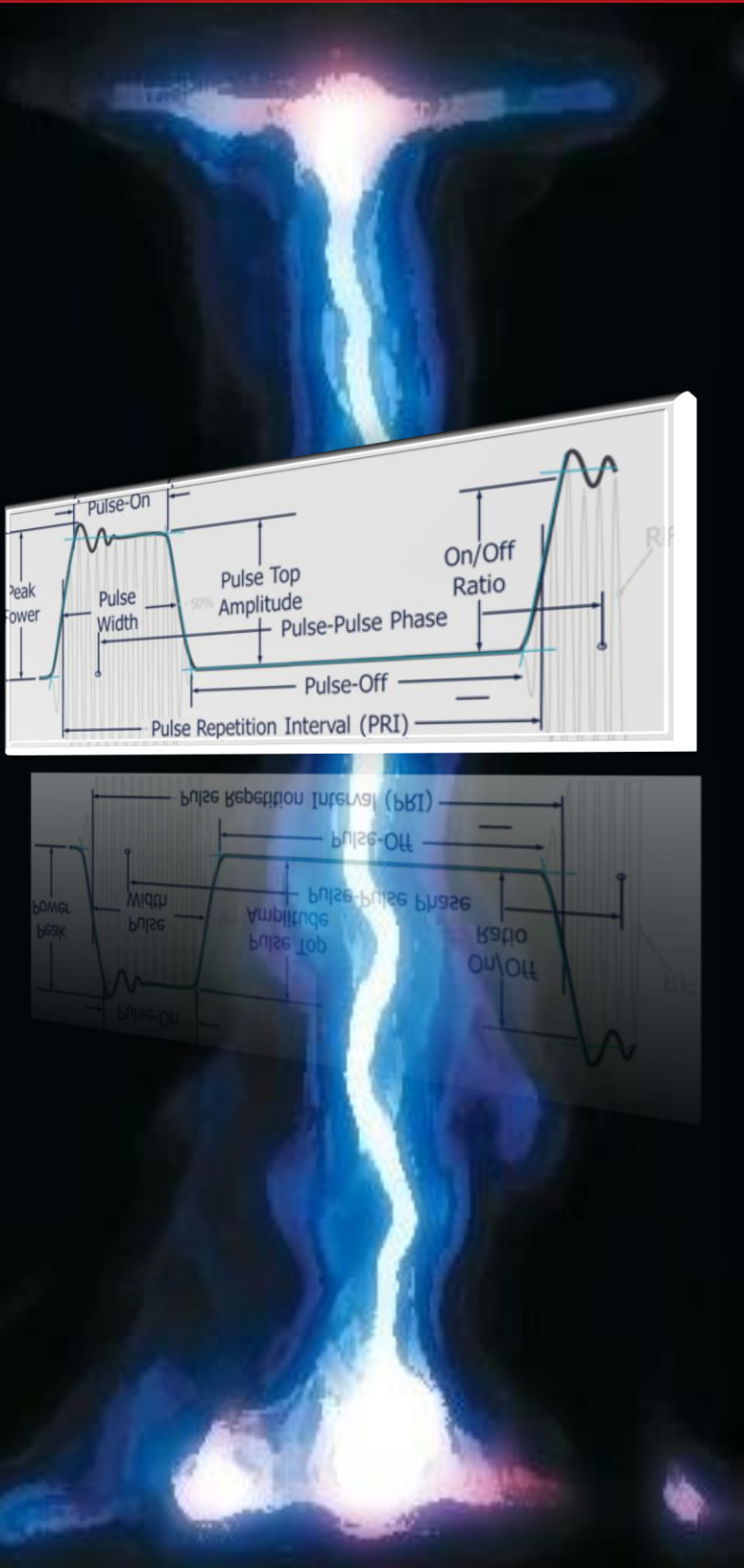
Alfven | 100™
Radio-frequency event detector

Typical Frequencies
400 kHz, 2 MHz, 13.56 MHz, 27.12 MHz, 40.68 MHz, 60 MHz

RF Power Range
0.25 W to 90 kW

Alfven | 100

The Alfven | 100 RF event detector is an advanced, all-in-one, diagnostic instrument for plasma arc detection and RF pulse monitoring. The Alfven 100 architecture enables real-time processing of RF measurements with one microsecond resolution. It is designed to detect and characterize arcs while simultaneously monitoring individual RF pulses to check that each pulse meets a predefined specification. Arcs and atypical RF pulses can lead for wafer defects, therefore, the Alfven 100 is an essential tool for rapid troubleshooting and 24/7 monitoring.

The Alfven 100 radio-frequency (RF) event detector is built on Impedans' best-in-class RF sensing platform. It is used to detect RF events such as arcs, pulses and instabilities. It has real time resolution of 1 µs to capture individual arcs or pulses in high definition on voltage and current measurements. The Alfven 100 is designed with the needs of live production in mind.

The sensor is network enabled, allowing seamless communication within the factory environment. For a fully connected solution, you can integrate with the plasma tool or the factory host through the ethernet interface. Industrial communication protocols such as EtherNet/IP and EtherCAT are available.

Key Features

- 1 µs resolution for arcs and atypical pulses simultaneously (with adjustable noise filter).

- Configurable arc and pulse classification widgets.

- Monitors ON-time, pulse frequency and duty cycle of individual pulses.

- Reports on deviations from user configured acceptance limits.

- ON-OFF and multi-level pulsing (up to 3 levels).

- Max, min & average voltage and current reported during pulses to monitor "overshoot".

- "Snapshot" function to view pulse profile at a given time.

- Recipe function, for multi-step processes.

Key Benefits

- Quickly determine if arcs or atypical pulses are responsible for wafer defects.

- Pulse snapshot feature avoids inconvenient directional coupler-to-oscilloscope setup.

- Monitor average pulse frequency and duty cycle of each process step with the recipe feature.

- Monitor the number of arcs per process, which may lead to undesirable particle creation.

- On-board, intelligent data processing – microsecond data only reported when requested.

- On-board memory to store data during network outage.

- Generate summary reports for your process

Low Cost of Ownership

Each sensor is configurable to detect any type of high speed RF event. It can be used to monitor the fidelity of individual RF pulses and detect arcs simultaneously. No other sensor on the market is capable of providing this type of dual-functionality.

Cost Benefits

Enormous cost benefits can be achieved through integration of the Alfven 100 sensing platform with OEM equipment. Whether integrated in the matching network, the RF generator or the plasma tool, cost benefits can be realized. Cost savings are achieved through general RF pulse health diagnosis and through the detection of undesirable arcing events with the process chamber – all of which, if not detected early, can result in scrap events of very valuable wafers or substrates.

Early Diagnosis

It is well known that arcs within a plasma processing chamber can damage the wafer directly or generate particles that cause defects on the wafer. Evidence suggests that catastrophic macro arcs are preceded by the onset of micro arcs which become incrementally more frequent as components in the RF path degrade. Early diagnosis is therefore key to protecting your equipment. RF pulse health and repeatability is similarly correlated with wafer detects. Monitoring individual pulses in terms of duty-cycle, pulse frequency, rise time and peak-height (among other parameters) can be used to establish limits for pulse parameter variability to ensure defect free wafer production and avoid scrappage.

Advanced Communication features

The Alfven 100 platform is equipped with a variety of communication options. Ethernet connectivity is used to interface with the Alfven 100 software suite. HTTP, EtherCat and EtherNet/IP protocols are available to communicate directly with the sensor.

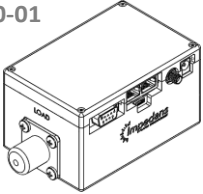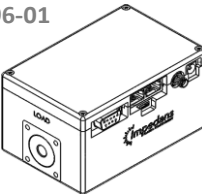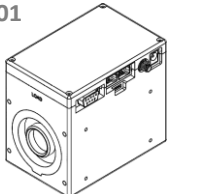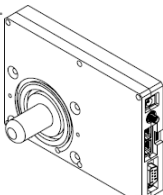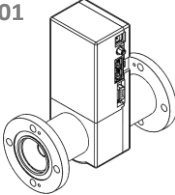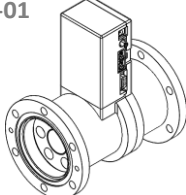## Simple Design for Ease of Integration

The Alfven 100 product has a convenient design consisting of a single, self-contained enclosure in which the analog detection modules, the digitization modules and the physical communication interfaces are all contained. The advantage is that the signals are digitized very close to where they are detected, dramatically improving signal to noise performance. Other products on the market consist of up to three separate components; analog sensing head, analog transmission cable and digitization/control box. The three components model makes the integration with OEM equipment more complicated.

Model Options

Table 1: Alfven | 100 – Model Specifications

Model #	Fwd Power Range[1]	Frequency Ranges[2,3]	Connector
02-0260-01	1.5 W – 12 kW	400 kHz – 121 MHz	QC Type
02-0496-01	1.5 W – 12 kW	400 kHz – 121 MHz	B6N Multicontact Socket[4]
02-0497-01	1.5 W – 12 kW	400 kHz – 121 MHz	B20N Multicontact Socket[5]
02-0498-01	1.5 W – 12 kW	400 kHz – 121 MHz	B20N Multicontact
02-0499-01	3 W – 30 kW	400 kHz – 121 MHz	EIA 1-5/8"
02-0500-01	9 W – 90 kW	400 kHz – 121 MHz	EIA 3-1/8"

Table 2: Alfven | 100 – Model Form Factors

02-0260-01	02-0496-01	02-0497-01
02-0498-01	02-0499-01	02-0500-01

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[1] Connector and VSWR dependent.

[2] One fundamental frequency can be selected within this range, each with a bandwidth of +/- 10%.

[3] Custom options also available

[4] Spade terminal and custom LC connector options available.

[5] Adapters for B20N-to-QC and other connectors available

Table 3: Model 02-0260-01 & 02-0495-01 Connector Options

MODEL DETAILS	STANDARD CONNECTORS[6]	
	HN FEMALE	HN MALE
	N FEMALE	N MALE
02-0260-01 & 02-0495-01 QUICK CHANGE (QC) INTERFACE	7/16" FEMALE	7/16" MALE
	LC FEMALE	LC MALE
	C FEMALE	C MALE
	EIA 7/8"	EIA 1-5/8"
	SPADE TERMINAL & PTFE BRACKET	

[6] Others available on request.
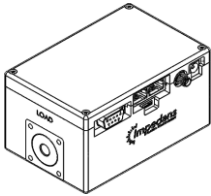
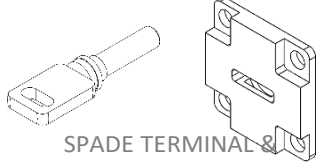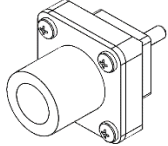*Table 4: Model 02-0496-01 Interface & Connector Options*
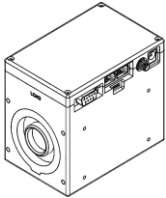
MODEL DETAILS	RF INTERFACE	CONNECTOR OPTIONS[7]
02-0496-01 6 mm MULTICONTACT (B6N) INTERFACE	RF INPUT (GENERATOR) & RF OUTPUT (LOAD) 6 mm SOCKET	SPADE TERMINAL & PFTE BRACKET
		LC FEMALE CONNECTOR

Table 5: Model 02-0497-01 Interface & Connector Options

MODEL DETAILS	RF INTERFACE	CONNECTOR OPTIONS[8]
02-0497-01 20 mm MULTICONTACT (B20N) INTERFACE	RF INPUT (GENERATOR) & RF OUTPUT (LOAD) 20 mm SOCKET	M10 SCREW
		20 mm PLUG

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[7] Custom options available on request.

[8] Adapters available on request e.g. B20N-to-HN
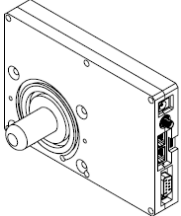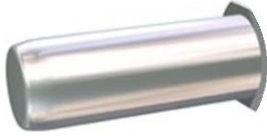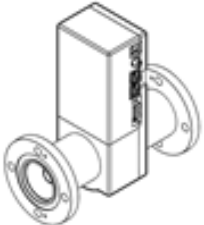
Table 6: Model 02-0498-01[9] Interface
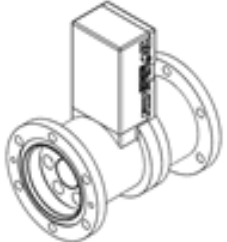
MODEL DETAILS	INPUT INTERFACE	OUTPUT INTERFACE
02-0498-01 20 mm MULTICONTACT INTERFACE 	RF INPUT (GENERATOR) 20 mm PLUG 	RF OUTPUT (LOAD) 20 mm SOCKET

Table 7: Model 02-0499-01 & 02-0500-01 Interface[10]

MODEL DETAILS	INPUT INTERFACE	OUTPUT INTERFACE
02-0252-01 EIA 1-5/8" INTERFACE 	RF INPUT (GENERATOR) INTERFACE EIA 1-5/8" 	RF OUTPUT (LOAD) INTERFACE EIA 1-5/8"
02-0306-01 EIA 3-1/8" INTERFACE 	RF INPUT (GENERATOR) INTERFACE EIA 3-1/8" 	RF OUTPUT (LOAD) INTERFACE EIA 3-1/8"

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[9] Ideally suited for OEM integration as generator output sensor or match unit input sensor.
[10] Adapters to other RF connector types available on request.

Connectivity Options

Connect directly to a PC through the RJ45 port. This requires a static IP address to be configured on both the sensor and the PC as described in the user guide.
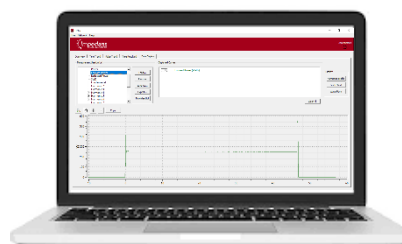
- or -

Connect the sensor and PC to your building network. Use the 'Scan Network' function in the Octiv software to locate and connect to the sensor.

Parameters Reported

Table 8: RF parameters measured by Alfven | 100 sensors.

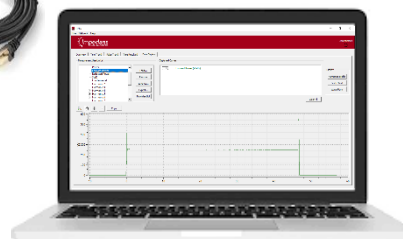| Parameters measured by the Alfven | 100 sensors (other RF parameters can be calculated and output on request)	
Arc Detection Mode	
V	RMS Voltage
I	RMS Current
# E11 ………. # E33	Number of RF Arc/Events in each category
# E_ON	Number of RF ignition events
# NOT AN EVENT	Number of recategorized non-events after reanalysis
Pulse Monitor Mode	
Avg. V	Average RMS Voltage during pulse on-time (for each pulse level)
Max. V	Maximum RMS Voltage during pulse on-time (for each pulse level)
Min. V	Minimum RMS Voltage during pulse on-time (for each pulse level)
Avg. I	Average RMS Current during pulse on-time (for each pulse level)
Max. I	Maximum RMS Current during pulse on-time (for each pulse level)
Min. I	Minimum RMS Current during pulse on-time (for each pulse level)
Pulse Freq.	Pulse Frequency in each level
Pulse Period	Pulse Period in each level
Pulse Duty Cycle	Pulse Duty Cycle in each level
# Pulses	Number of pulses in a particular run
# E_PE	Number of pulses out of specification limits
Additional outputs	
Snap	Snapshot function to capture a pulse waveform with 1 µs resolution for a 5 ms window

Specifications

Table 9: General Specifications

Alfven | 100 – General	
Calibration Standard	Indicative calibration, accuracy not necessary for RF pulse and arc monitoring
Calibration Cycle	Recalibration not necessary
Sensor Characteristic Impedance	50 Ohms as standard
RF Connectors	See table 2
RF Power Range	Standard: 12 kW typical (connector dependent) High Power: 30 kW & 90 kW models available on request
Operating Temperature Range	10^0 C – 100^0 C
Sensor Power Requirements	15 - 24 V DC, 0.5 A
Communication Interface	RJ45x2
Connectivity (Impedans Software)	Ethernet
Communication Protocols (Standard)	HTTP Web Service
Communication Protocols (OEM Options)	EtherCAT, EtherNet/IP
Form Factor	Self-contained single unit 58x70x107mm standard. Dimensions for other models AOR.
Parameter Report Rate (Standard)	Ethernet: 10 S/s

Table 10: Frequency Specifications

Alfven | 100 – Frequency	
# Fundamental Frequencies (F_0)	Choose 1 from the fundamental frequency range. Measures 1 frequency at a time.
F_0 Range	$350\ kHz - 121\ MHz$
F_0 Specials	$40\ kHz$ & $162\ MHz$ models available on request
F_0 Modes	CW, CW with Tuning, Multi-level Pulsing with Tuning
F_0 Tracking Rate	$10\ kHz/\mu s$
F_0 Tracking Range	$\pm\ 10\%$ or $\pm\ 2\ MHz$, whichever is less

Table 11: Voltage & Current Specifications

Alfven | 100 – Voltage & Current	
Voltage Dynamic Range	80 dB
Voltage Range (Typical)	$0.3\ V\ to\ 3000\ V_{RMS}$, custom available
Voltage Resolution	$0.1\ V_{RMS}$
Current Dynamic Range	80 dB
Current Range (Typical)	$2.5mA_{RMS}\ to\ 25\ A_{RMS}$, custom available
Current Resolution	$2.5\ mA_{RMS}$

Table 12: Pulse Monitoring Specifications

Alfven | 100 – Pulse Monitoring	
Acquisition Method	RMS detector, live streaming with 1µs resolution
Pulse Frequency Range	5 Hz to 100 kHz
Pulse Time Resolution	$1\ \mu s$
Pulse Level Monitor	Up to 3 levels e.g. high-low-off
Pulse Level Monitor [Report Rate]	< 10 S/s (pulse frequency dependent)
Recipe Configuration Limit	40 process steps

Table 13: Arc Detection Specifications

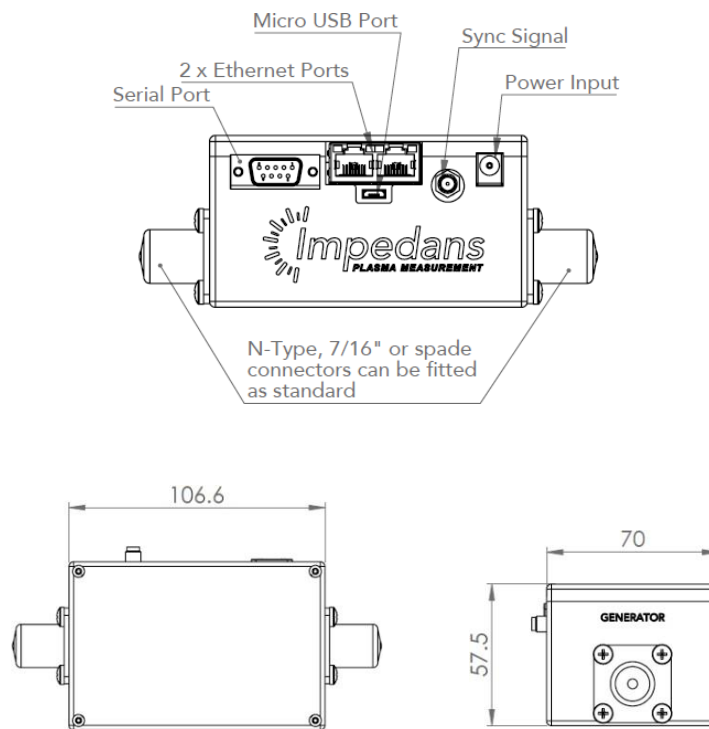| Alfven | 100 – Arc Detection	
Arc Duration Range	1 µs – 5000 µs
Arc Amplitude Range (vs Moving Avg.)	1% – 100% change
# Arc Categories	9 (x3 time duration & x3 amplitude deviation)
Onboard Storage	14 hours of average VI data 5000 atypical pulses or arc events

Dimensional Drawings

Figure 1: Dimensional drawings of the Alfven | 100 model 02-0260-01. All dimensions are in mm. RF connectors are interchangeable. Drawing for other models available on request.
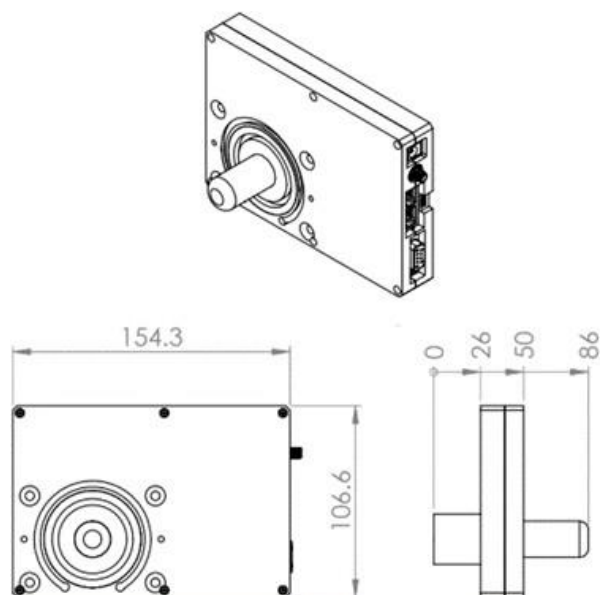

Figure 2: Dimensional drawings of model 02-0498-01.
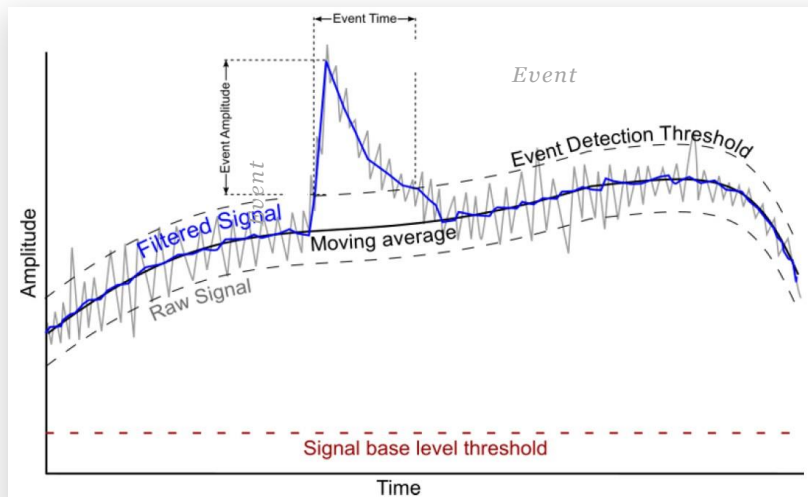
Arc and Pulse Parameter Definitions

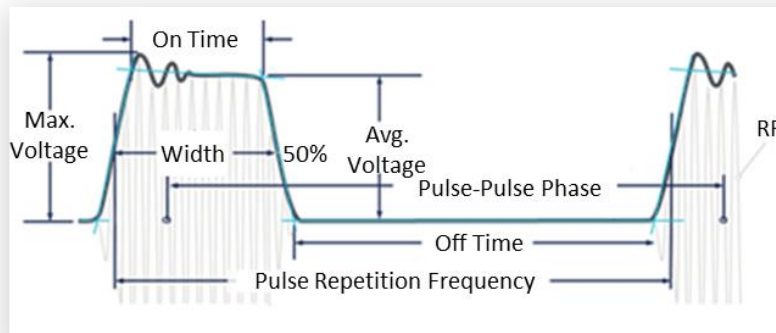*Figure 3: Illustration of the arc definition used for arc detection with the Afven 100 sensor.*

Figure 4: Illustration of the pulse parameters used for pulse monitoring with Alfven 100 sensor.

Software Screenshots