

# AMS1300

## Smart Spectrometer™

The AMS1300 Smart Spectrometer™ is a high pressure fully integrated small footprint process mass spectrometer.

At the heart of the AMS1300, is a pre-calibrated modular sensor comprising an ion source, the mass filter and the Faraday Cup detector. In addition, the AMS1300 unit houses a sampling sub-system, all control electronics and the complete vacuum pumping assembly. The system is out-of-the-box plug-and-play ready in less than 5 minutes and supports an Internet-of-Things (IoT) ready Ethernet port communications and easy to use web browser based software user interface.

With the AMS1300, individual gas components are ionized and then separated using a patented array of miniaturized quadrupole mass filters. Patented algorithms then calculate the molar fraction of each gas component giving high accuracy quantitative data.

### Key Applications

- Lyophilization (freeze-drying)
- Fermentation monitoring and control
- Semiconductor abatement systems
- Thin-film vacuum coating
- Semiconductor etch and deposition
- Leak detection
- Environmental monitoring
- Safety and security
- Natural Gas

### Key Hardware Features

- 1 amu (FWHM) resolution
- 100 amu range\*
- Real-time data from 10mS/amu
- Quantitative mol% and pressure data
- High  $5 \times 10^{-3}$  Torr operating pressure

\*Contact Atonarp for higher (>100) amu range



### Key Hardware Features (cont).

- Integrated roughing and turbo pumps
- <5min start-up time out-of-the-box
- Ultra-small <0.01m<sup>3</sup> total size
- Field-replaceable sensor and filament
- Internet-of-Things ready Ethernet port
- 1ppm sensitivity for N<sub>2</sub>
- Minimum partial pressure as low as  $1 \times 10^{-9}$  Torr for N<sub>2</sub>
- >6 orders of magnitude linear range
- <100W power consumption

### Key Software Features

- Browser based user interface
- Full and select m/z scans
- User settable electron emission and ionization energy
- Flexible graphic interface: Spectrum, bar chart, mol% and mol% fraction history
- User defined alarms and actions
- System diagnostics access
- Multiple report types and formats supported
- Remote diagnostics and updates
- Support for Cloud based services

## Absolute Maximum Ratings

Specification	Value
Ambient Temperature	0°C to 40°C
Relative Humidity	80% non-condensing
Hydrocarbons C <sub>(1-8)</sub>	<50% at 1x10 <sup>-3</sup> Torr
Corrosive Gases	<10% at 1x10 <sup>-3</sup> Torr

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to AMS1300. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications (below) is not implied. Device reliability may be affected by exposure beyond absolute maximum rating conditions.

## Operating Characteristics

Unless otherwise specified characteristics are under the following conditions: Nitrogen equivalent. T<sub>(ambient)</sub> = 25°C

Parameter	Conditions	Min	Typ	Max	Units
Mass Range		2		100	amu
Mass resolution	Full Width Half Maximum Note 1	0.9	1.0	1.1	amu
Mass number stability			0.1		amu
Sensitivity	Note 1, 3	4.5x10 <sup>-6</sup>	5.0x10 <sup>-6</sup>	5.5x10 <sup>-6</sup>	A/Torr
Linear response range	0.4mA emission Note 3	1x10 <sup>-9</sup>		5x10 <sup>-3</sup>	Torr
Detectable partial pressure	Note 2, 3	1x10 <sup>-10</sup>	1x10 <sup>-9</sup>	1x10 <sup>-8</sup>	Torr
Detectable concentration	Note 2, 3	0.5	1	10	ppm
Operational pressure				5x10 <sup>-3</sup>	Torr
Discrete m/z sample rate				100	Hz
Sampling pressure range		1x10 <sup>-5</sup>	1x10 <sup>-3</sup>	1x10 <sup>3</sup>	Torr
Operating temperature	80% relative humidity non- condensing	5		35	°C
Emission current		0.01	0.4	1	mA
Emission current accuracy			±1		%
Start-up time			3		minutes
Measurement Accuracy			±1		%
Repeatability			±0.1		%
Power consumption	24VDC			100	W
Weight			4		kg
Size	Length		256		mm
	Width		204		
	Height		200		

Notes:

- Using factory calibration
- Limits dependent on dwell time
- Min and Max values based on initial product characterization

## AMS1300 patented quadrupole architecture

Key to AMS Smart Spectrometer™ small form factor (<math> < 0.01\text{m}^3 </math>) is the miniaturized quadrupole filter array. This array of sixteen cylindrical micro-rods generates nine quadrupoles in the spaces bounded by four rods in conventional quadrupole architectures (figure 1)

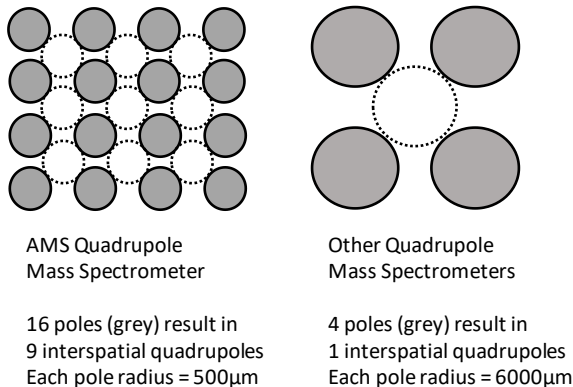


Figure 1. AMS1300 patented quadrupole architecture

The AMS1300 achieves the same resolution as larger quadrupoles by using higher frequency RF to offset the shorter quadrupole filter. The shorter ASM1300 quadrupole filter allows for higher pressure (mtorr) operation than conventional quadrupole systems without compromising sensitivity.

The higher-pressure operation of the AMS1300 Smart Spectrometer enables the vacuum pumps to be integrated inside the unit, rather than being external devices as with residual gas analyzers (RGA). The AMS1300 generates a higher ion current, which allows the Smart Spectrometer to have a rugged and stable Faraday Cup ion detector, sensitive to ppm concentrations across more than six decades of dynamic range.

The AMS1300 sensor architecture requires no calibration compared to architectures that utilize an electron multiplier detector. Additionally, the AMS1300 faraday cup detector offers advantages including robustness and unlimited lifetime.

Proprietary algorithms then accurately calculate the mole fractions of each gas component with an accuracy of better than 1%. The results appear in real-time in a browser-based software controller.

The AMS Smart Spectrometer is calibrated using an industry standard Capacitance Diaphragm gauge.

## Mass Spectrometry for Process Control

High pressure operation is not the only benefit that the AMS1300 quadrupole architecture brings to process control applications. Unlike RGA solutions the AMS1300 has integrated turbo and roughing pumps dramatically simplifying equipment deployment and commissioning.

The AMS1300 is powered by a single low power 24V DC power source and communication to the system for control and data extraction can be performed via the available 10/100/1000MB/s Ethernet port, USB2.0 or RS232/485. Analog and digital I/O enable flexible and easy interfacing, integration and control of external sample delivery or other process control systems.

## Plug-and-Play Ready

The AMS1300 is a highly integrated system that comes plug-and-play ready for process control applications.

The physical view of the AMS, the various connection functions (figure 2) and panel descriptions associated with the AMS are described below.



Figure2 The front panel of AMS. For detailed connector description refer Table 1 and 2.

Table 1: AMS1300 front panel connectors

Connector	Description
On/Off Icon	Press this switch to enable electrical power to the system. Press and hold for 10 seconds to power-off the system
Power 24V DC IN	Connect power cord from the provided AC-DC adapter
Ethernet	A 10/100/1000Mbps Ethernet interface is provided for high speed communications and control. User interface loads through this connection
USB 2.0 - USB Host	USB 2.0 port for keyboard, mouse, hubs and storage devices for expansion
USB 2.0 - Micro USB Host OTG	USB 2.0 Host or Device (OTG) configurable port. OTG mode to program the AMS. Host mode for keyboard, mouse, hubs and storage devices for expansion
COMM	Interface for serial communication. Configured from factory for any of these serial protocols via a DB-9 connector – RS232/RS485/RS422
Analog/Digital I/O	The AMS system can connect to external devices such as valves through this interface
Ground	Electrical ground connection to the AMS
SW1	Custom Switch 1
SW2	Custom Switch 2
Exhaust	Connect to an external vent to safely dispose the used gas. The venting of the AMS exhaust must be in accordance with all federal, state, provincial, and local health and safety regulations

Table 2: Status LED description

LED	STATUS	Description
PWR	Off	System electrical power not available
	Orange	System electrical power available
	Green	On/Off icon pressed and in On state
SYS	Orange	Main CPU initializing
	Green	Main CPU ready
IL1	Orange	Selected emission source off or out of convergence
	Green	Selected emission source on
FIL2	Orange	Emission source 1 selected
	Green	Emission source 2 selected
NET	Orange	Not connected to Network (No IP address assigned)
	Green	Connected to Network (IP address assigned)
SCN	Alternating	Scan in progress
	Green/Orange	
	Orange	Scan stopped

## Software

The dashboard is the primary user interface view for the user to interact and monitor the functioning of the AMS.

Key features include:

- Power on and Workflow profile selection
- Spectrum display
- Mole Fraction display – trend and real time
- System Logs
- Gauges displaying system parameters
- CFR11 compliant

The AMS user interface provides instrument customizability and exposes many configuration parameters that govern the behavior of the instrument.

Many of these parameter values can be saved as profiles. A profile is a user specifiable label for a fixed set of parameter values. This allows a user to switch between various recipes to suit specific application requirements.

Once the system has powered-up, reached vacuum and initialized (approx. 3 mins) a scan can be performed. An example scan is shown (figure 3).

network cable. In this usage scenario, the AMS must be configured as a DHCP server that will assign an IP address to the user system.

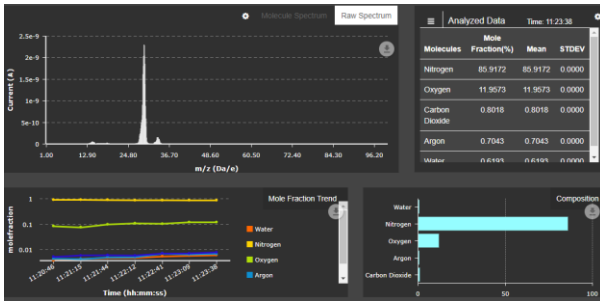


Figure 3: Example post scan dashboard view showing detected m/z peaks and relative mole fraction percentage

Data generated for each scan is time stamped and stored on the AMS system allowing the system to run autonomously and data to be retrieved at a later time if required. Popular data export formats such as .json and .csv are supported

Repeated scans are called workflow and while the workflow is in progress, the mass spectrum and the mole fractions are continually updated in the user interface (figure 4).

Metrology information; spectral information; sensor, pressure and vacuum diagnostics; preventative maintenance schedule and operational control are all supported in Atonarp's Cloud based solution.

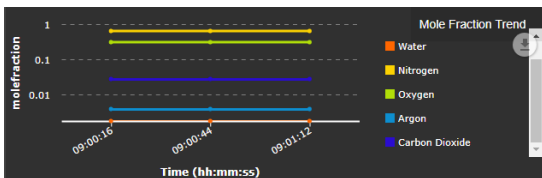


Figure 4: Mole fraction trend is updated after each scan

Atonarp offers additional analytics, multiple system access and other solutions via Cloud services.

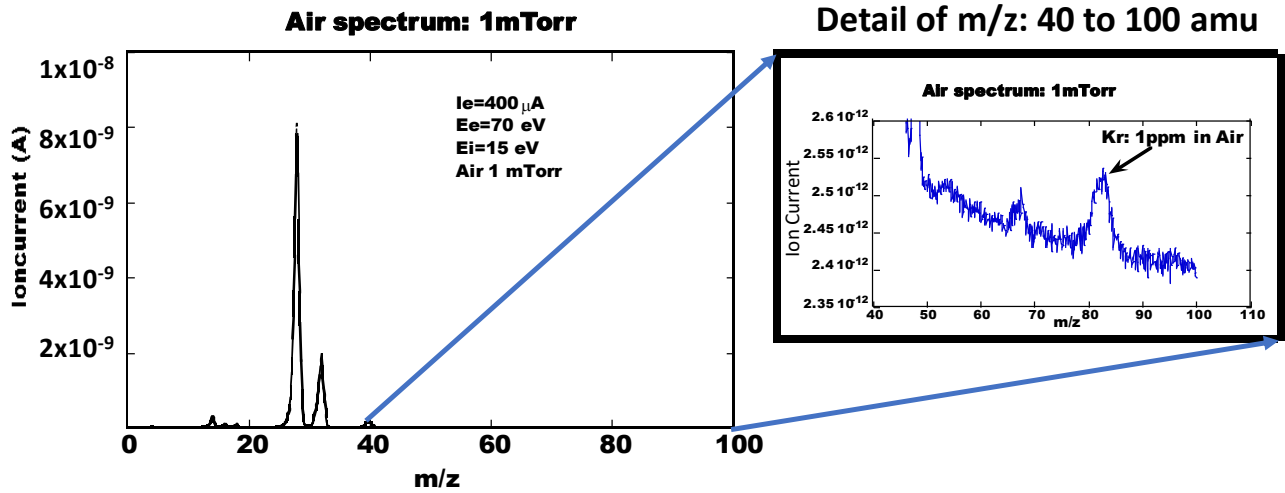
## Communication with AMS1300

The simplest way to communicate with the AMS in an already networked environment like an office is to connect the AMS' Ethernet port via a network cable to the enterprise (office) network. The AMS Ethernet port is 10/100/1000MB/s and performs optimally when the networking equipment are also gigabit compliant. When this connection is made, a DHCP server running in the enterprise network is expected to assign an IP address to the AMS system. The user can then open the web browser and access Atonlab by typing the AMS URL <https://ams-xx.atonarp.local>.

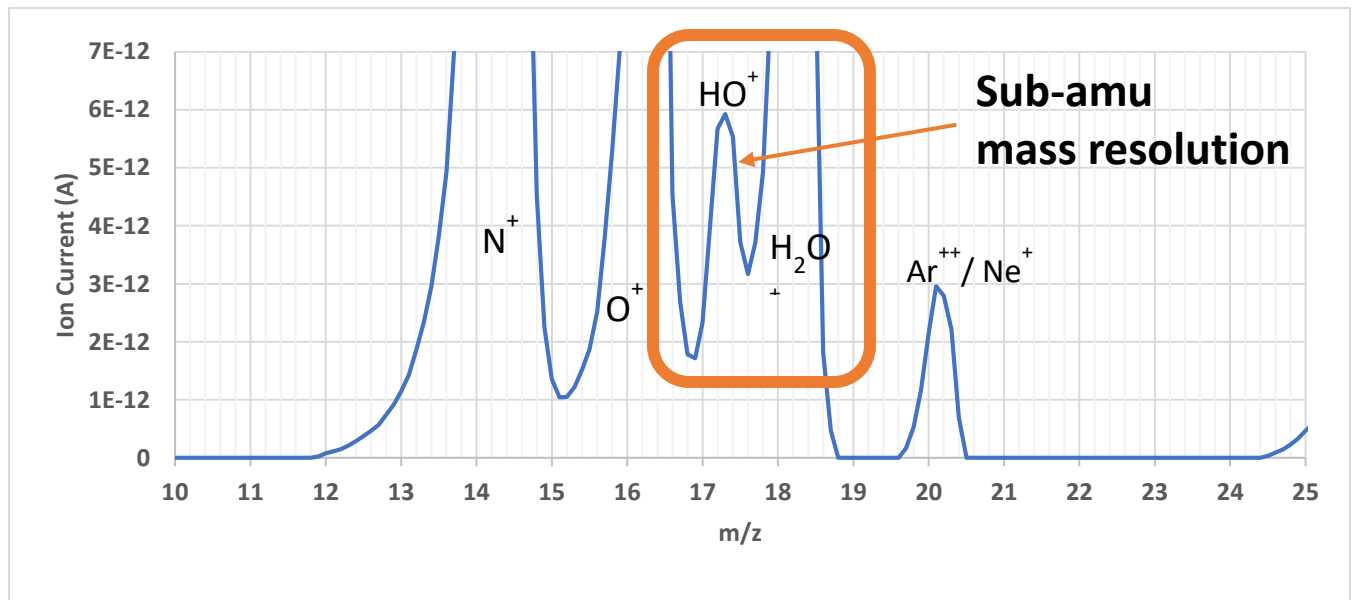
In the absence of an enterprise (office) network communication with the AMS can be performed with a direct connection between the AMS Ethernet interface and the client system using a

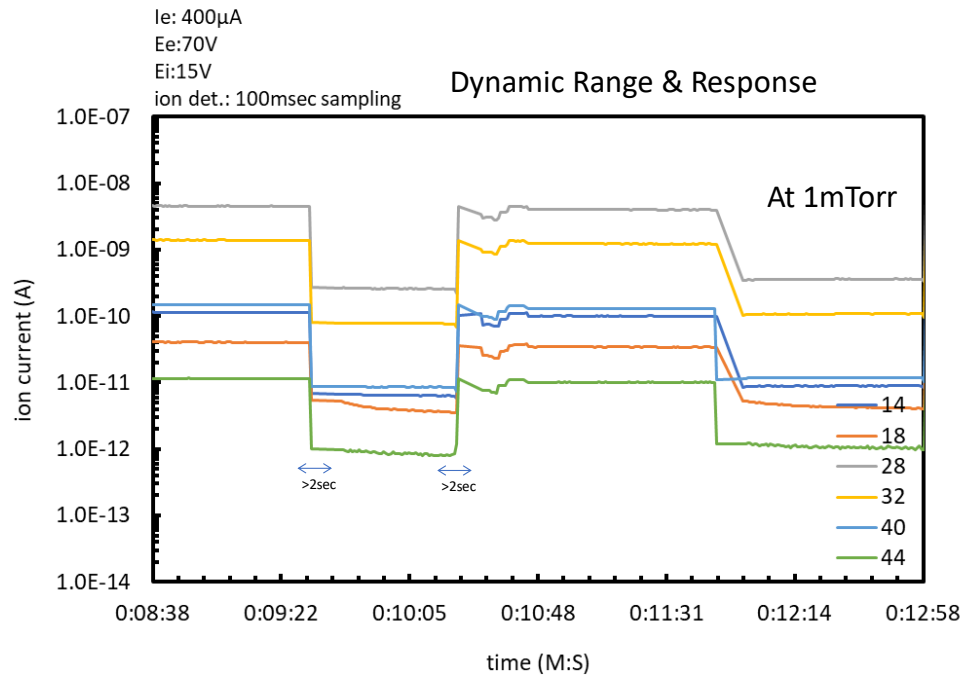
## Typical Operating Characteristics

Low PPM sensitivity (<1ppm)



## Sub-amu mass resolution

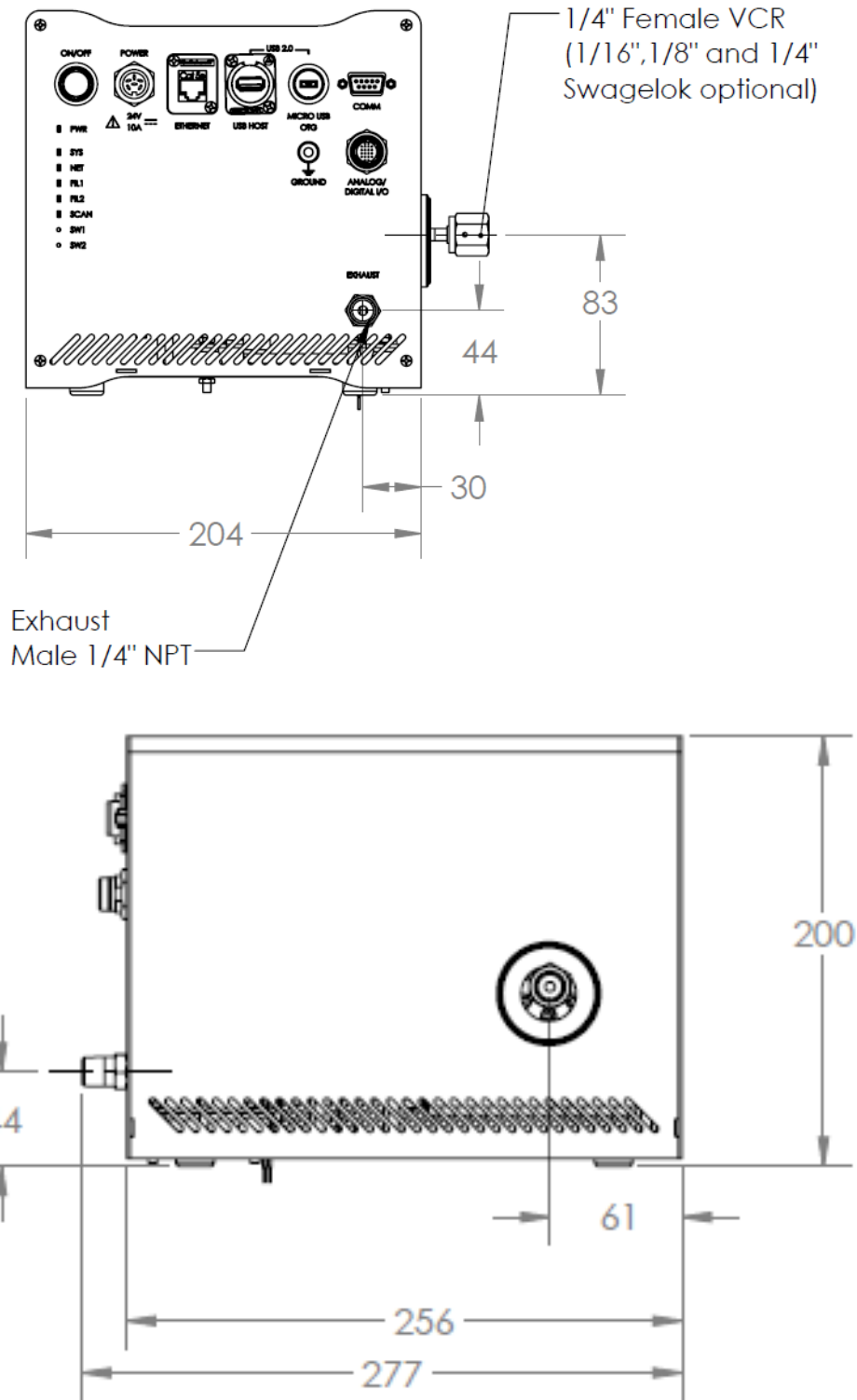


**Dynamic Range and Response**




## Dimensional Drawings

All dimensions in mm unless otherwise stipulated





## Ordering information

Instruments:	Part number
AMS1300 complete unit	AMS1300
AMS controller box with sensor/vacuum chamber plus pressure sensor. (without pumps, cabling and housing)	AMS-100-0001 plus AMS-860-0017
Consumables:	
Sensor/filament	AMS-860-0007
Pirani pressure sensor	AMS-860-0017
Copper gasket	AMS-860-0005

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