

# Mass Sensors, Inc.

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Innovations in chemical microsensors

## Profile

Mass Sensors is a development stage high-tech company operating in the chemical instrumentation/sensors industry. Our sensor products provide reliable and quick response in various chemical detection applications. These universal chemical/gas sensors provide unique fingerprints for virtually any chemical substance. On-board software can tune the sensor to different chemicals, detect their presence and report results in the span of a few seconds.

## Technology

The heart of our sensor products is a miniature double focusing mass spectrometer (MS). Our unique MS analyzer design and fabrication method (patent pending) provides MS performance at the price of a sensor. Key features include:

- Small size
- Wide mass range: 1-200 daltons for detecting chemicals across a wide range all in the span of a few seconds
- True chemical fingerprints less prone to false identifications and interferences
- Versatile communications including wired and wireless access with web interface. Local display and keypad are also available
- Easy to use with complete auto calibration and diagnostics
- On-board data logging and alerts

A number of prototypes have been developed and are currently being evaluated by the chemical industry and strategic partners. The company's product concept has been validated by the successful completion of three NASA contracts and a current Department of Defense contract to detect chemical warfare agents

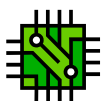
## Applications

Our sensor products are designed for a host of application markets. These include:



### Chemical Process Streams

- in line process monitoring and diagnosis in chemical manufacturing



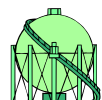
### Semi conductor manufacturing

- vacuum quality and in-situ process monitoring



### Emissions Monitoring

- Minimize pollutants, green house gases



### Fermentation

- online measurements of carbon dioxide, oxygen and hydrocarbons



### Worker safety

- low level toxics detection and fugitive emissions



### Industrial Hygiene

- emergency response to hazardous spills, work place monitoring



### Medical

- Breath diagnostics, anesthetics monitoring



### Petrochemical drilling/refineries

-isotope ratios, methane, carbon dioxide analysis



### Leak Detection

- Hydrogen/Helium/refrigerant leak detection. Product quality control

Mass Sensors will focus its efforts as an OEM supplier in several of the above markets. We are currently seeking strategic partnerships with major companies to license our unique technology into these markets.

## Gas Monitoring

Our revolutionary sensors will have a major impact on a host of key markets currently served by different types of gas sensing equipment including gas chromatographs(GC), mass spectrometers(MS), infrared(IR), electrochemical(EC) and conductive polymers.

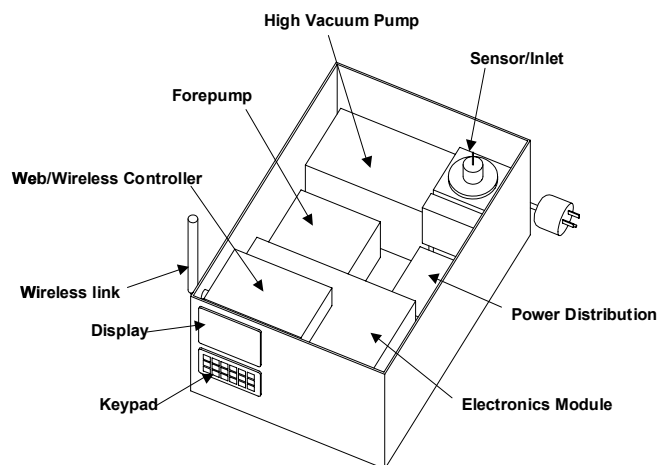
GC/MS and IR solutions are expensive and require a great deal of maintenance and expertise to use and analyze results. In process plants long sampling lines carry the sample to one central instrument. In other applications bagged samples are sent to labs for analysis with several hours or even days waiting for results. EC sensors are simple and inexpensive but not specific to a particular gas and give false alarms depending on the application and may be affected by temperature and humidity.

Mass Sensors provides the most compelling price-to-performance alternative for your gas sensing needs. Our compact sensors can be installed directly at the source of the sample and can function as either portable/survey monitoring gas sensors or continuous single point/multi point monitors.

### Product Concept

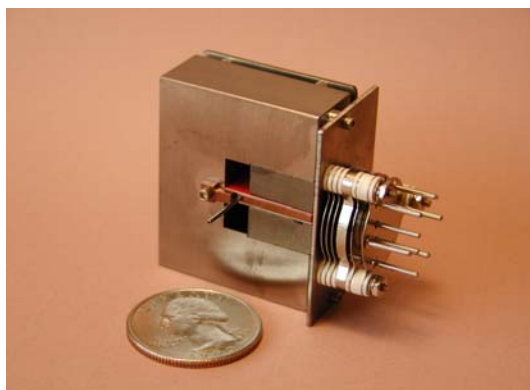
A system consists of three elements- the miniature sensor, the electronics module and the vacuum system. Figure 1 below shows example of an integrated system. For customers who provide their own vacuum system only the electronics module and sensor mounted on a specified flange are provided.

Figure 1: An integrated system



**The sensor:** Figure 2 below shows the microscale sensor. The source, analyzer and detector are modular and allow them to be replaced easily.

Figure 2: Sensor



**Inlet system:** The inlet assembly can be offered in various configurations to match your application. This includes a continuous leak valve, a pulsed valve, or an optional gas sniffer probe. The system can continuously sample gas at low flow rates with a very fast response time.

**Gas Monitoring Software:** The versatile software allows you to run the sensor in various modes, including analog scan, histogram and trend. The automatic data logging mode allows you to monitor up to 16 gases using a programmable method in which you can specify the rate, schedule and conditions of data acquisition. Both archived and real time data can be accessed any time. The software also allows you to specify interfering gases and include them in the analysis for alerts. Data can be displayed and stored in ppm, partial pressures, absolute/relative intensity, ratios or specifying a custom calculation. Data is stored in ASCII format and can be exported to other user applications.

**Gas Alarm Set Points:** You can set alarms up to three levels for each gas being monitored, specifying actions for each level. A warning level alarm can send out an email alert and display or sound a warning signal while a critical level alert can activate relays to further trigger an appropriate action.

**Communications:** The sensor can be controlled using several communication protocols. These include a local keypad and display, serial communication (RS232/485), LAN(10BaseT), internet (TCP/IP) and wireless. This allows the sensor to be used in stand-

alone or multi-point networked applications. The sensor controller is also equipped with both a 4-20mA analog output and a RS-485 Modbus digital I/O port. This facilitates the transfer of readings to a PLC or plant wide data acquisition system.

**User Interface:** A web interface makes our sensors platform and location independent. Our sensor ID application can scan your entire local network and identify all the installed sensors. A unique IP address and an assigned user ID and password allows connection to the sensor. You can use the local keypad and display to connect if the sensor is not on a network or connect directly via a PC using LabView.

**Electronics module:** Figure 3 shows the electronics module consisting of the communications controller, data acquisition hardware and power supplies. These electronics allow the user to program the sensor, perform calibration, set up methods, alarms etc. using wired and wireless communication.



Figure 3: Electronics module

**Vacuum system:** Figure 4 shows an integrated system and is based on the product concept shown in figure 1. This 10"x10"x14", 20 lb system consists of a turbo molecular pump, a diaphragm pump, a small vacuum chamber for the sensor and power supply for the pumps. The oil free pumps allow the unit to function in any orientation. The control electronics for the sensor can also be embedded into this system to make it a completely portable gas sensing unit.



Figure 4: Integrated Vacuum System

#### Characteristics of good sensors:

- Small and rugged
- Low energy consumption
- Easy operation and maintenance
- Reliable and accurate performance
- Cost effective

Our sensor products offer all these characteristics. Use them for monitoring

- Hydrogen & Helium
- Volatile Organic Compounds
- Total hydrocarbons
- Fuel vapor monitoring
- Toxic and explosive gases
- Combustible gases
- Process monitoring
- Stack Monitoring
- Breath testing

# SPECIFICATIONS

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## Mass Range

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Model R8 : 1-50 daltons  
Model R30 : 1-200 daltons

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## Source

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Emission regulated EI source. Two filaments

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## Mass Filter Type

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Double focusing (E X B) Mass Spectrometer

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## Detector

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Electron Multiplier:  $1 \times 10^8$  at 2000V  
Faraday cup available

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## Sensitivity

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Electron Multiplier: Large dynamic range allows detection of 1-10 ppm levels  
Faraday Cup: Helium sensitivity  $5 \times 10^{-7}$  A/Torr

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## Response Time

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To 90% of signal < 10 seconds

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## Linearity

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Measurements at various pressures of He and Ar show linearity in pressure up to mid  $10^{-4}$  Torr range

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## Mass Stability

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$\pm 0.1$  AMU after 30 minute warm up. Peak height is  $\pm 2$  % after 30 minute warm up

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## Dimensions and weight (sensor only)

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Dimension (MM) : 60(H) X 70(W) X 70(D)  
Weight : 220 gm

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## Operating pressure range

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$10^{-4}$  Torr to ultra high vacuum

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## Power consumption

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Sensor : 3W  
Electronics Module : 10W  
Vacuum system : 55W

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## System physical dimensions

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Electronics Module : 10"x8"x5"  
Total weight of electronics module : 6 lbs  
Integrated system with vacuum : 16"X16"x10"  
Total weight of integrated system: 20 lbs

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## Operating Temperature

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Maximum ambient operating temperature 80 deg C

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## Communications

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Local/Industry Bus: RS-232, RS-485, ModBus  
TCP/IP: Web access over Internet or PC based access over network  
Wireless: ½ mile radius wireless access using spread spectrum or long distance wireless using CDPD

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## Data from Sensor

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The next page shows some data runs from the sensor.

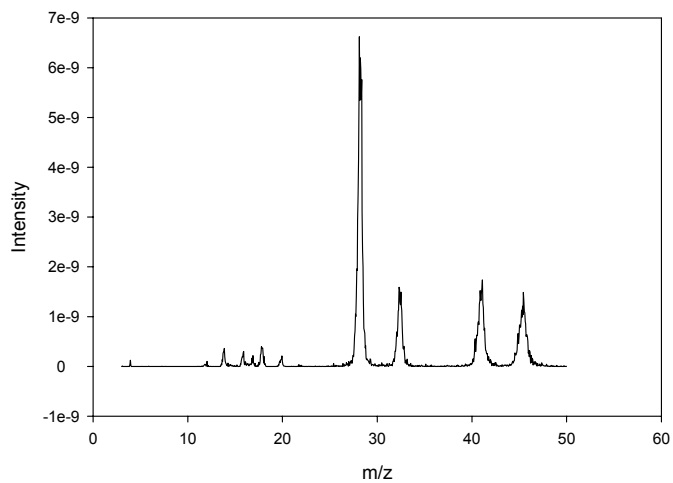
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### For more information please contact:

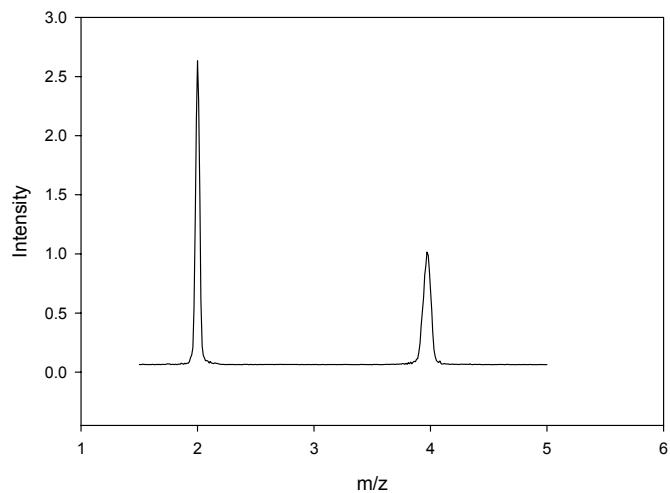
Rajiv Chhatwal  
(314)997-5779  
rajiv.chhatwal@mass-sensors.com

### Spectrum from sensors:

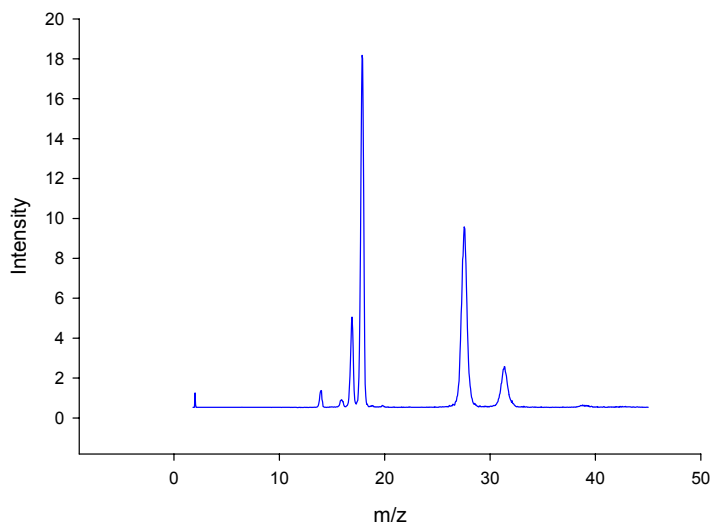
Air, He, Ar, CO<sub>2</sub>  
30 July 2001



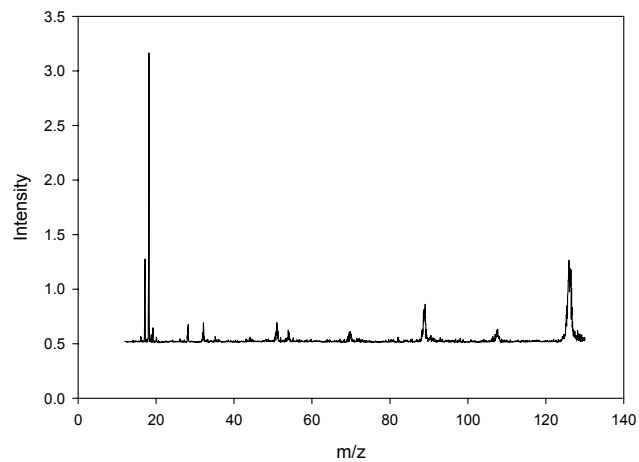
Hydrogen and Helium separation



### Spectrum of air



SS200  
SF<sub>6</sub>, 3.3 x 10<sup>-5</sup> Torr  
19 December 2001



Resolving Power ~100 at m/z = 18, m/z = 127