# Automatic weighing system (AWS) for gravimetric evaluation of dust-loaded filters with a diameter of 47 mm

## Type AWS-1

# Environmental Monitoring Systems

**Automatic weighing system (AWS) used to weigh dust-laden filters with a diameter of 47 mm for registration and documentation of particulate matter** (Pat. pend.)

**Type: AWS-1**

**The automatic weight determination system (AWS) registers and documents the amount of particulate matter in outdoor air in compliance with the EN 12341:2014 ($PM_{10}$ and $PM_{2,5}$) standards. The particulate matter is collected on filter media with a filter diameter of 47 mm mounted in volume samplers in combination with specimen sampling systems.**

- Very exact, automatic weight determination system for filters with a diameter of 47 mm
- Automatic registration and documentation of particulate matter concentration
- Tremendous reduction of measurement deficiencies
- Great reduction of stress and strain for personnel
- Air-tight housing to isolate the weighing system from the outside world. This is to keep the system from being contaminated by airborne particles and to maintain the specified climatic conditions (temperature and humidity).
- When the AWS is set up in an appropriately conditioned atmosphere (e.g. 20 °C and 50 % relative humidity) one may, of course, operate the system without the integrated climate control feature.

**Options:**

- Integrated temperature and humidity regulation
- Integrated marking station
- Wind protection device with a soft-closing mechanism for the weighing cell unit
- Ionisation blower for Teflon filters
- More filter magazines for the conditioning chamber are available
- Micro balance:
  Mettler-Toledo weighing cell WXS26S/15 or
  Sartorius weighing cell WZA-26-NC
  (other micro balances can be used on request)

## Introduction of the automatic weighing system

Several European Union directives require that the particulate matter present in outside air be measured. In most cases reference units (low-volume samplers) are used for this purpose. A vacuum pump is used to draw particulate-laden air into the device, the particulates are sorted by size in separation stages (impactors) and the dust particles thus recovered are deposited on a filter. In the past, the amount of dust thus collected was ascertained by manual weighing at an outside laboratory. Where non-continuous registration and ongoing monitoring of the dust concentration are required, the usual technique is to employ filter changers that automatically remove individual filters after a defined exposure period and place them in a magazine. The collector unit is then fitted with a fresh filter. In this way dust can be collected for subsequent evaluation over a relatively lengthy period of time.

The type AWS-1 automatic weight determination system was developed to register and document the amount of particulate matter in outdoor air. Automatic weighing of filters eliminates the need to weigh the filters manually. This simplifies the staff's work considerably. Errors in determining and recording the measured values, resulting from human subjectivity, are virtually excluded. Both the clean filters and the dust-laden filters have to be weighed several times to arrive at a mean value. This results in a very large number of weighing operations, representing considerable strain for personnel due to the concentrated but monotonous nature of this work.

The filters are stored – both prior to the collection cycle and then for a certain period of time after exposure – at a specified temperature and defined relative humidity level. This makes it necessary for the automatic weighing system to be capable of maintaining these defined atmospheric conditions.

The particulate concentration, expressed in micrograms per cubic meter (µg/m³), is calculated on the basis of the difference in the weights of the laden and clean filters, taking account of the total volume of air processed during the collection period.

One prerequisite for running the entire process automatically is marking the individual filters, thus making them identifiable. A separate filter marking system (optional) is used for this purpose. The corresponding reader is installed at the AWS-1 to identify the filters.

## Filter disk magazine

The newly developed disk magazine is mounted on the carrier rack and can be populated with 10 or 20 magazine disks, each holding 16 filters with a diameter of 47 mm. The disk magazine is rotated in discrete steps by way of a brushless DC motor with an attached incremental encoder. Any of the 160 or 320 filter locations can be accessed individually by a filter conveyor fork.

The magazine disks are 2.4 mm thick and made of glass-fiber reinforced epoxy resin (FR4). Similar disks are used in manufacturing printed circuit boards. The upper surfaces of the magazine disks are gold-plated. The filters are always placed at the gold-plated positions intended for the filters, this being in the interest of preventing static build-up. At the same time the gold plating is used to equalize the electrical potential for all 10 or 20 magazine disks.

An integrated handgrip makes it easy to insert the disk magazine, with its 10 or 20 magazine disks, in the AWS-1 and then to remove it once again.

Filter disk magazine

## Microbalance

The scale used here is a microbalance, readable to 0.001 mg. Other micro balances can be used on request. The balance was modified mechanically for this operation so that the filter conveyor fork can lay the filter to be weighed on the balance and then remove it again. The modifications to the balance have no influence on the technical data guaranteed by the manufacturer of the balance. (Additional technical information may be found in the manufacturer's specification sheet.)


Microbalance

## Reader station to identify filters

As has already been mentioned, one prerequisite for automating the weighing process is the requirement to mark and identify the filters.

Where the filters are 47 mm in diameter and the exposure area is 41 mm in diameter, an annular area 3 mm wide will be available for marking. A digitally controlled cutting device, not a part of the weighing system, is used to place a binary code on the edge of the filter. Each marking is about 2 x 1.75 mm in size. The programming for these codes is handled by the control and data recording PC, where „filter marking“ software is installed.

The filter is identified at the reader station integrated into the AWS. The binary code applied to the edge of the filter is read by a digital vision sensor. Once it has been read, the binary code is stored in the memory of the PC used for control and data recording.

## Filter identification

The following measured values are stored at the beginning of the weighing and conditioning process in conjunction with identifying the filter exposure conditions:

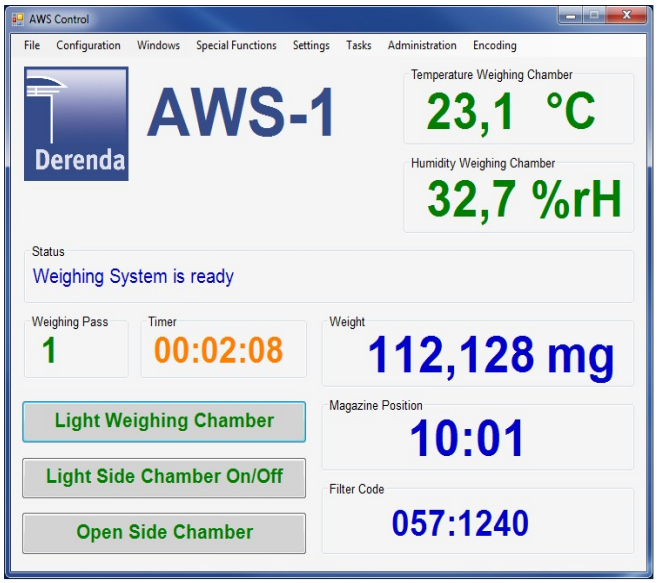
- Temperature
- Rel. humidity
- Atmospheric pressure
- Conditioning period
- Number of the magazine disk
- Filter position on the magazine disk
- Filter code for identification purposes
- Date and time of day
- Collection period
- Mean value derived from the number of weighing cycles selected, before and after exposing the filter to particulate matter

## Equipment to control the temperature and humidity of the air inside the enclosed handling and weighing system

The automatic weighing system will have to maintain defined atmospheric conditions by controlling the temperature and humidity. Any ingress of foreign, airborne particles will have to be prevented. The system is thus closed with a protective hood.

The temperature is maintained with a climate control unit for heating and cooling.

The AWS is also fitted with an evaporator as air cooler unit offering great operational reliability. It is able to maintain the specified relative humidity exactly. The system is very quiet and economical and features superior regulation properties. Included among the safety features are an overheating sensor, overflow sensor and protection against dry running.




Start window with data display

When the AWS is set up in an appropriately conditioned atmosphere (e.g. 20 °C and 50 % relative humidity) one may, of course, operate the system without the integrated climate control feature.

## Filter conveyor unit

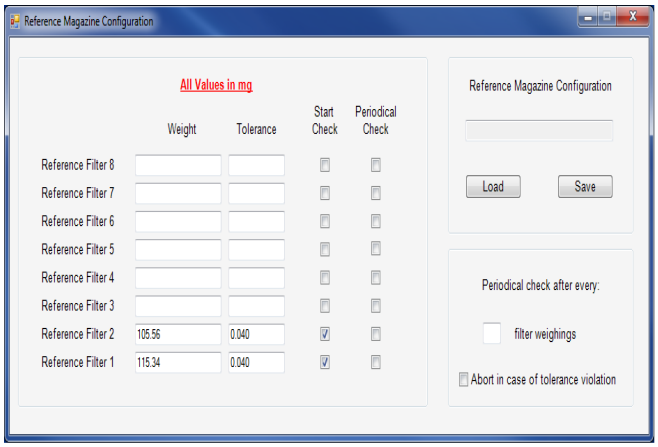
The device is fitted with a filter conveyor fork that can be moved both radially and vertically.
It moves radially to access these positions: filter identification, filter balance, disk magazine and calibration weights.
Moving along its vertical axis, the filter conveyor fork removes the filters from the disk magazine and lays them down at the appropriate stations.
The filter is returned to the disk magazine once the identification and weighing cycle has been completed.
The disk magazine may be changed out after all the filters on hand are weighed.

## Intermediate check of the balance using the calibration weights

The system is programmed to conduct an intermediate check of the balance, using the calibration weights integrated in the ballance. These calibration weights are normally more precise than external weights.

In addition, a calibration with external weights can be realized by laying the weights on the balance manually .

The magazine in a specimen sampling system is fitted with 16 filter cassettes containing filters; one of these filters is a so-called „blank filter“ (reference filter). It is used to determine the passive accumulation of dust in the specimen sampling system's changing unit.
Once the magazine disks in the automatic weight determination system have been fitted with filters taken from the cassettes in the specimen sampling system, the reference filter will be weighed before the start of each weighing cycling to determine the potential need for corrective measures.




Menue of reference magazine configuration

In addition, the automatic weight determination system provides space for eight additional reference filters. These may be made from one of several different materials (e.g. fiberglass filter, quartz fiber filter cellulose nitrate filter or Teflon filter).

These are kept in the reference filter tower, making it possible to detect – by weighing these filters – any accumulation of dust in the weighing chamber itself.

The materials used for the reference filters are identical to those in the filters used to collect fine dust. These filters are changed out together with the filter diskmagazine.

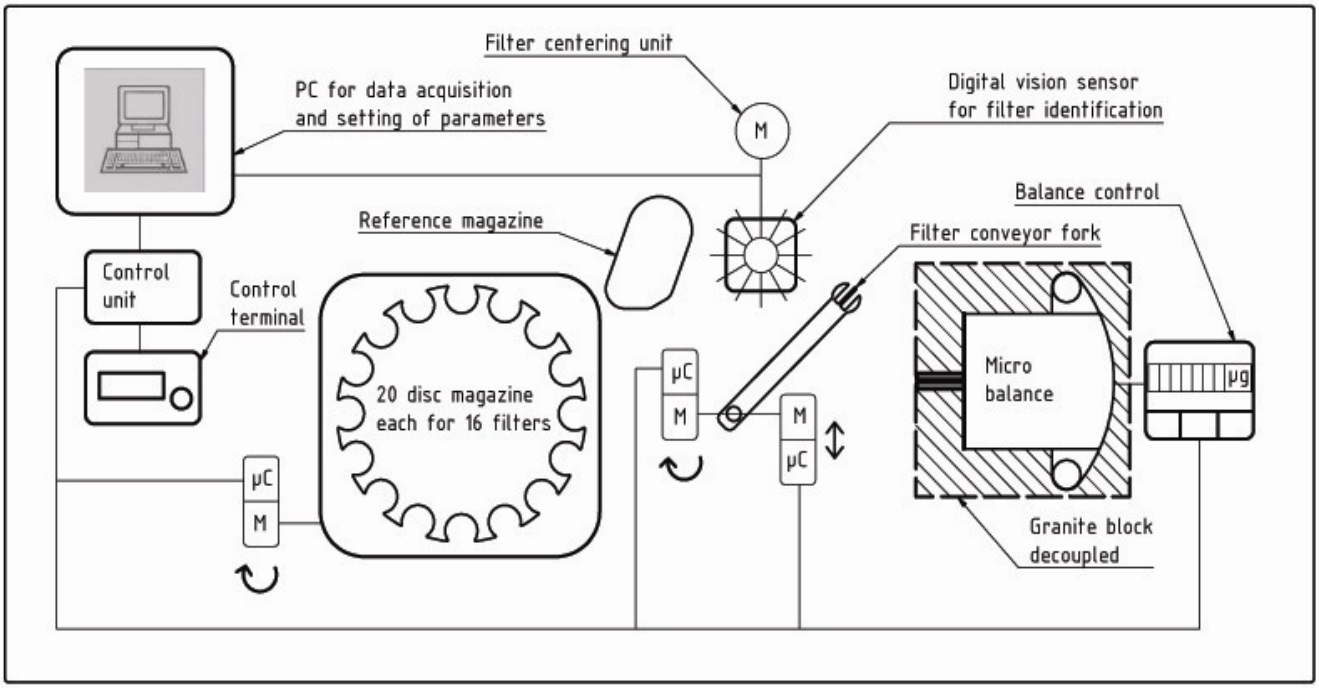
## Evaluation and documentation

The supplied evaluation software can be used to post-process the data stored in databases or in an Excel spreadsheet. Custom modifications can be provided as extra-cost options.
In addition to the data mentioned above, the weights of the non-laden and laden filters will be stored after the weighing process is completed.

## Information on the filter materials

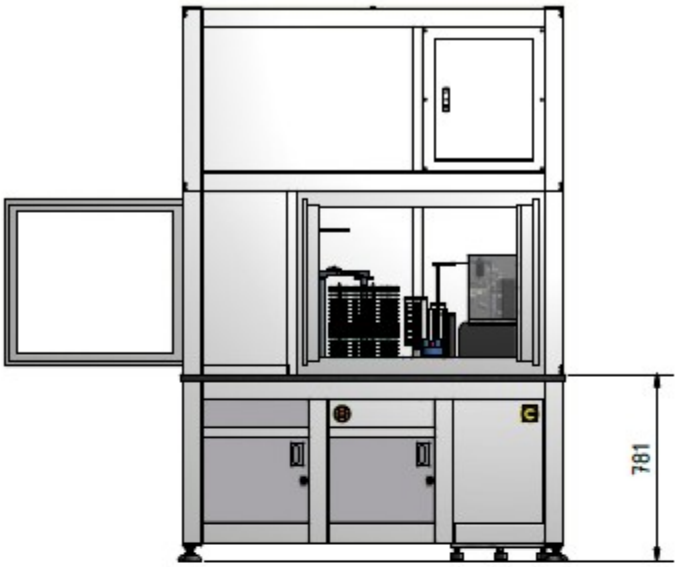
The following filter materials can be weighed with the AWS-1:

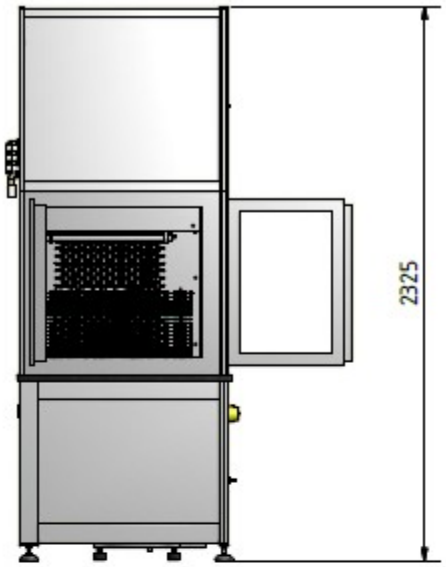
- Glass fiber filter
- Quartz fiber filter
- Cellulose nitrate filter
- Teflon filter (without coding)

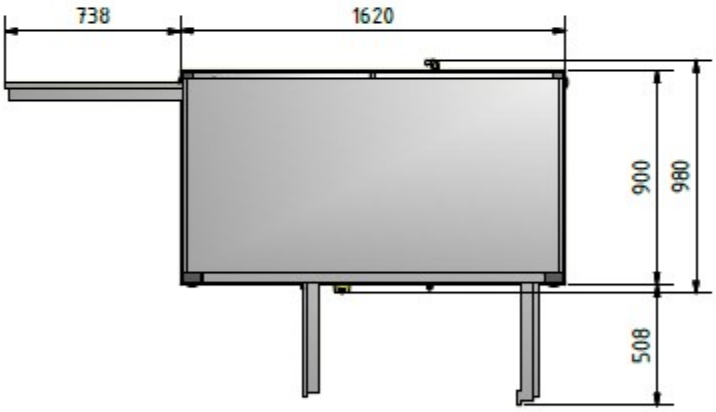


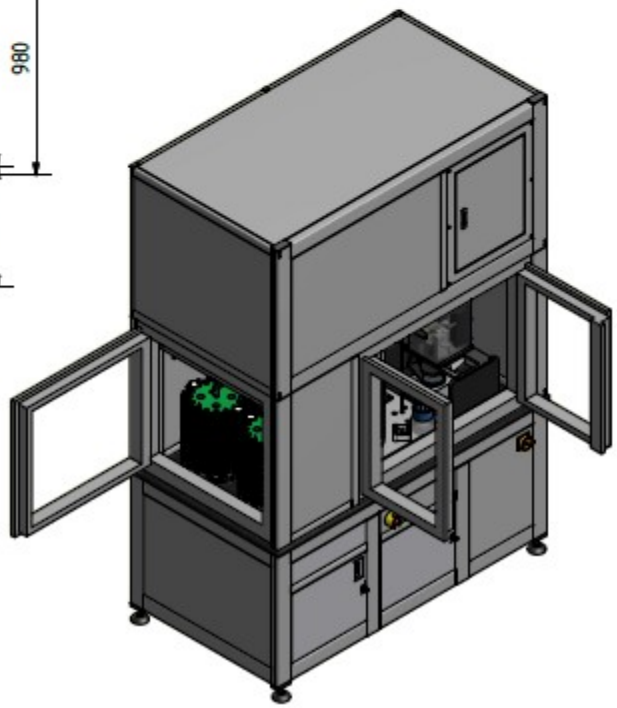

Block diagram

## Dimensions



Dimensions in mm

## Technical Data Automatic Weighing System Type AWS -1

**Filter disc magazine**

| | |
|---|---|
| Number of magazine discs holding filters: | 10 or 20 |
| Number of filters / magazine disc: | 16 |
| Potential equalization: | By means of cone contacts between the gold plated magazine discs |
| Drive system of the disc magazine: | Brushless DC motor (maintenance-free) |
| Positioning of the disc magazine: | By means of incremental encoder |

**Filter**

| | |
|---|---|
| Filter material: | Glasfibre filter<br>Quartz fibre filter<br>Cellulose nitrate filter<br>Teflon filter (without coding) |
| Filter diameter: | 47 mm |
| Filter marking: | By use of digitally controlled cutting device (optional) |
| Position of marking: | On the edge of filters (can not be used for teflon filters) |
| Dimension of marking: | 2 x 1,75 mm |
| Type of marking: | Binary code (approx. 129.000 opportunities) |
| Reader station: | Vision system |

**Microbalance** (optional)

| | |
|---|---|
| Manufacturer: | Mettler-Toledo Microbalance cell WXS26S/15 or<br>Sartorius Microbalance cell Type WZA-26-NC<br>(other micro balances can be used on request) |
| Reading precision (resolution): | 0.001 mg |
| Maximum load: | 20/22 g |
| Location of microbalance: | Platform with a large mass (approx. 200 kg), decoupled from the main mounting rack |
| Calibration weights for weighing system: | Integrated in the balance |

**Data output**

| | |
|---|---|
| Data output: | RS232 |
| Data export (CSV data file): | Weight of unloaded filter (average) |
| (other data formats on customer request): | Weight of loaded filter (average)<br>Difference of weight of unloaded and loaded filter (average)<br>Temperature, humidity rel., barometric pressure<br>Filter number<br>Sampling number<br>Date / time<br>Amount of weighings per filter |

**Power**

| | |
|---|---|
| Power supply: | 230 V +/- 10%, 50 Hz |
| Power consumption: | 250 VA |

**Dimensions and weight of mounting rack**

| | |
|---|---|
| Length: | 1.620 mm |
| Width: | 900 mm |
| Height of operation: | 860 mm |
| Height with protective hood: | 2325 mm |
| Overall weight (inclusiv granite block for balance): | approx. 600 kg |

**Conditioning of climate (optional)**

| | |
|---|---|
| Temperature regulation: | climate control unit (heating and cooling) with water (external compressor) |
| Humidifier unit: | Evaporator as air cooler unit |
| Permissible operating and environmental conditions: | 15-32 °C, 30 - 60% rel. humidity |
| Power consumption: | approx. 2000 VA |
| Power consumption of compressor: | approx. 1500 VA |

# Environmental Monitoring Systems

Comde-Derenda GmbH in Stahnsdorf bei Berlin

Comde-Derenda GmbH was originally founded as an engineering office in Berlin, in the year 1972. The company's activities at that time included the development, production and sales of measurement and control systems and gas analysis systems.

Over the course of time the engineering office focused on the development and production of devices and systems for the collection of particulates in the ambient air, used in the field of environmental protection.

COMDE GmbH was founded in the year 1992. The company in particular concentrated on the development and production of equipment to measure and monitor pressure, gas density in high voltage circuit breakers (containing SF6 gas) and pressure at high temperatures. Moreover, the company developed and produced several white canes designed to increase the mobility of those who are visually impaired.

Our own building was erected in Stahnsdorf near Berlin, in 2007. All the activities of the three existing fields of operation gas density and pressure monitoring, environmental monitoring systems, and white canes are con- centrated here.

The engineering office and COMDE GmbH were merged to form Comde-Derenda GmbH in the year 2012.

Comde-Derenda GmbH has been certified as per the DIN EN ISO 9001:2008 standards for quality assurance.

Comde-Derenda GmbH can supply far more than the products found in its product overview. A wide range of custom-engineered equipment can also be manufactured.

If you are interested in a product or accessory item and you do not see it in our line, then please be sure to ask.