EIGENBRODT®

FOG DETECTION AND COLLECTION

TECHNICAL ALTERATIONS

- The technical description corresponds to the current products. Alterations because of technical improvements are possible. Requested functions or features are only binding, if confirmed in a contract in written form.
- Specifications are subject to change without prior notice— Errors and omissions excepted.
- Goods are subject to prior sale

ILLUSTRATIONS

- Please take into account, that illustrations are intended to clarify certain points. There may therefore be discrepancies between the illustrations and the written text.

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UNIT OVERVIEW – CONTENT

EIGENBRODT® develops and produces Precipitation Sampler and – Analyser for more than 25 years very successful.

The instruments are in use worldwide and all year round under several climatic conditions at the measurement sites of our customers. (Universities, Environmental Departments, Weather Services, Research Institutes, Industrial Companies)

It is possible to fulfil most of the wished applications with the range of offered standard configurations.

Specific applications or adaptations to special environment conditions are possible. Please challenge us.

German EPA measuring site on Sylt Island

- Suitable for all year use
- Sensitive Precipitation Sensors for all environmental conditions
- Very low service and maintenance requirements

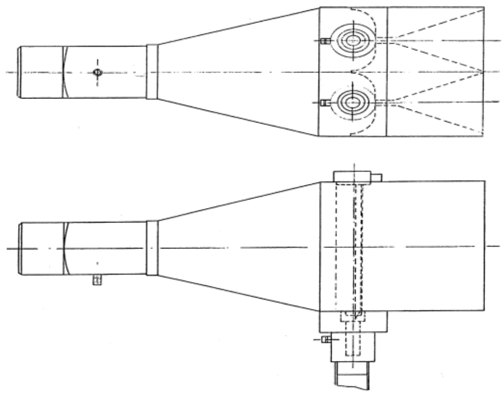
EIGENBRODT® FOG SAMPLERS

FOG WATER COLLECTION ON THE IMPACTOR PRINCIPLE

All types of Eigenbrodt fog sampler feature the same principle of collection:
Fog water is collected with a sampler operating on the impactor principle (see figure). The air is sucked at a rate of rd. 125 m³/h through a twin nozzle behind. A specially designed deposition body is placed onto which the fog droplets are impacted. The deposition body has a vertically oriented hole in its centre which is connected to the impaction surface by numerous small bored holes. The centre hole and the instruments exits are connected by tubes so that a slight under pressure is applied sustaining a slight air flow through the capillary holes.

The deposition body has a small rim at each side preventing the deposited water from being ripped off and carried away with the fast air stream. The fog droplets which are deposited coagulate and this water is sucked into the small holes due to capillary forces and under pressure and drains into the centre from where it flows into two collection bottles.

By this way a rapid separation of the collected water from the strong air stream behind the nozzle is reached and problems as evaporation or continuing reactions are minimized. Behind the nozzle the air is guided by semicircular surfaces to the exit in order to avoid turbulences



(Schematic view of the FOG SAMPLER and the deposition bodies.)

Functionality	NES 210	NES 215	ANES 220
Manual switching on/off the sampling mode	✓	✓	—
Fog sensor allowing automatic switching on/off the sampling mode	—	—	✓
System completely built for outside operation all year long	—	✓	✓
Sample bottle 2x50 ml DURAN glass	✓	—	—
Sample bottle 250 ml DURAN glass	—	✓	✓
Rugged and reliable side channel blower	—	✓	✓
Regular vacuum cleaner, that needs to be sheltered against ambient influences	✓	—	—
Thermoelectric-cooling/heating for sample bottle	—	✓**	✓**
Timed security switch off for vacuum cleaner / pump	—	✓	✓
Automatic stop of sampling outside temperature limits	—	O	✓
Stand for fog sampler	O	O	O
Data logging	—	O	O

—: not available **O**: optional available ✓: Standard feature of this type
* Sampling can be automatically switched on/off with external digital fog signal (to be provided by customer)
** System can optionally be provided without thermoelectric-cooling/heating system

FOG SAMPLER NES 210 – MANUAL FOG SAMPLER WITH REGULAR VACCUM CLEANER


NES 210 with vacuum cleaner (subject to change) and optional stand.

FEATURES:

- New design – combines a high efficiency with a low dispersion - Design: German Weather Service; Meteorological Observatory Hohenpeißenberg, Dr. Peter Winkler
- Regular vacuum cleaner
- Manual switching on/off

SPECIFICATIONS

Sample unit	
Length x width x height:	360 x130 x 260 mm
Weight:	Approx. 2,1 kg
Sampling orifice:	120 x 120 mm
Operating temperature:	+0…40°C
Collection volume:	2x50 (borosilicate glass bottles)
Collection height:	Approx. 1700 mm (including optional stand)
Vacuum cleaner	
Dimensions vacuum cleaner length x width x height	35x35x40 mm (subject to change)
Connected power	220/230V,50/60Hz, 1000 W (1250 W max)
Legth hose:	Approx. 1,5

CONTENS OF DELIVERED PROGRAM

Sample unit
Vacuum cleaner
2 x 50ml bottle borosilicate glass
Documentation

OPTIONS

Extra bottle DURAN glass, 50ml
Stand

Vacuum cleaner is not built for outside use. Customer End-user needs to take appropriate actions to protect the machines electrical parts against ambient influences. (User has to provide weather protection for the vacuum cleaner)

FOG SAMPLER NES 215 – MANUAL FOG SAMPLER WITH SIDE CHANNEL BLOWER

Robust construction due to die cast aluminium
Ruggedness and proven reliability

Cooled/heated

Not cooled/heated

FEATURES

- New side channel blower (working in pumping mode) with extended life time compared with vacuum cleaner.
- Basic frame out of Alu-profiles, PVC-plates planked housing
- Integrated collecting system
- Automatic thermoelectric (Peltier) cooling/heating for the sample.
- Manual switching on/off the blower, or triggered by external digital signal.
- Electronics (switch) for switching on/ off is installed into lockable electronic housing
- Can be mounted onto regular Eigenbrodt precipitation collector stand.

SPECIFICATIONS

Sample unit	(integrated into housing)
Length x width x height:	360 x130 x 260 mm
Weight:	Approx. 1,9 kg
Sampling orifice:	120 x 120 mm
Operating temperature:	+0…40°C
Collection volume:	250ml (borosilicate glass bottle)
Collection height:	Approx. 1800 mm (including optional stand)
Complete unit	
Length x width x height:	440 x 750 x1090 mm (including shelter and optional fog sensor)
Weight:	Approx. 65 kg
Connected power	220/230V,50/60Hz, 1300 W

CONTENS OF DELIVERED PROGRAM

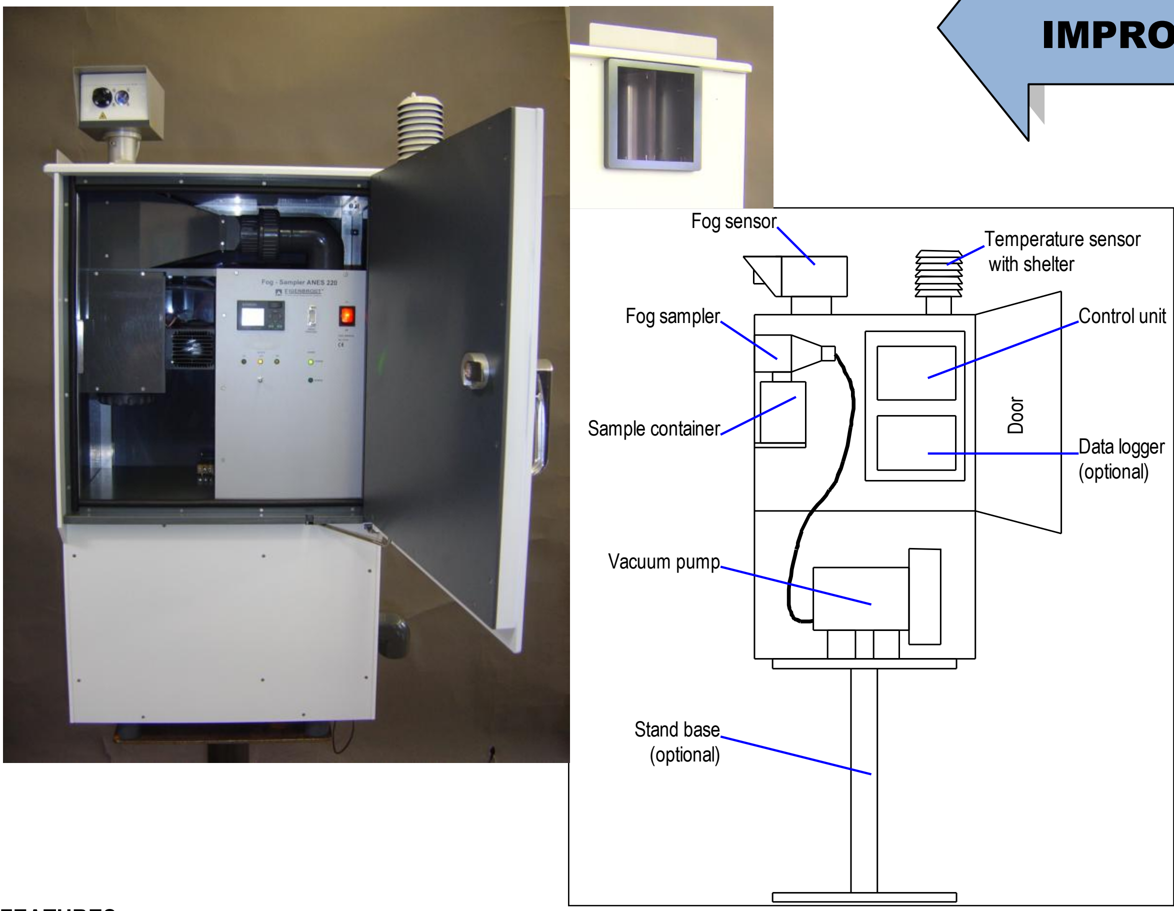
Sample unit, integrated
Side channel blower
Thermo-electric cooling/heating system for sample
Rugged housing for outside operation
Documentation

OPTIONS

Downgrade for no heating/cooling
function for the sample bottle
Extra bottle DURAN glass, 250ml
Data logging with signal PCB memory
Stand base
Fog sensor
Temperature/humidity probe with 2x1V output
Automatic switching off below 2°C and above 17 °C
Stand base

AUTOMATIC FOG SAMPLER ANES 220

IMPROVED



FEATURES

- Fog sampler operating on the impactor principle with new design – combines a high efficiency with a low dispersion
- Sample design: German Weather Service Meteorological Observatory, Hohenpeißenberg; Dr. Peter Winkler
- Housing construction for all year operation
- Single sample bottle 250ml (borosilicate-glass)
- Thermoelectric integrated heating and cooling of the sample
- Electronics for switching on/ off the blower is installed into lockable electronic housing.
- Automatic optical fog detection in order to automatically switch on and switch off the fog sampling.
- Rugged and reliable side channel blower (working in pumping mode) with extended life time compared to vacuum cleaner application.
- Thermoelectric cooling and heating
- Temperature/Humidity probe analogue signal output. Built into radiation shield and mounted at the side of the sampler.
- Temperature switch off deactivates automatically the blower with temperatures below 2°C and above 17 °C. This avoids freezing of the fog near 0°C and overheating of the blower at high temperatures.
- Optional: Data logging with signal PCB NES memory, logging temperature, humidity, visibility and time switching on/off the blower. The data logger can easily be programmed and read out via a regular terminal program, e.g. Putty (or similar).

TECHNICAL DESCRIPTION

CONTROL OF AUTOMATIC OPERATION

The laser based visibility sensor ONED 250 detects the visibility of the fog. In case the visibility is below a set point for a certain time, the control electronics starts the operation of vacuum pump, which continuously sucks fog through the fog sampling device. In case the visibility is above the set point for a certain time the pump is stopped.
The sampling process is also stopped when ever the ambient temperature is below 2°C in order to prevent the twin nozzles blocking by icing. In most climate conditions there can be no fog expected with temperatures higher than 17°C, therefore also the sampling is being stopped automatically. (limits can be changed on customer request)
An automatic system also prevents from damages by switching off the side channel blower for a certain time after a defined time of continuous operation.

CLIMATE CONTROL FOR THE SAMPLE

A controlled thermoelectric heating and cooling system for the samples enables all year operation of the fog sampler. – The sample keeps longer the composition of chemicals.

DATA LOGGING (OPTIONAL)

The basic information as switching on/off the pump; ambient temperature and humidity can be logged by an (optional) data logger, which is built into the main housing.

SPECIFICATIONS

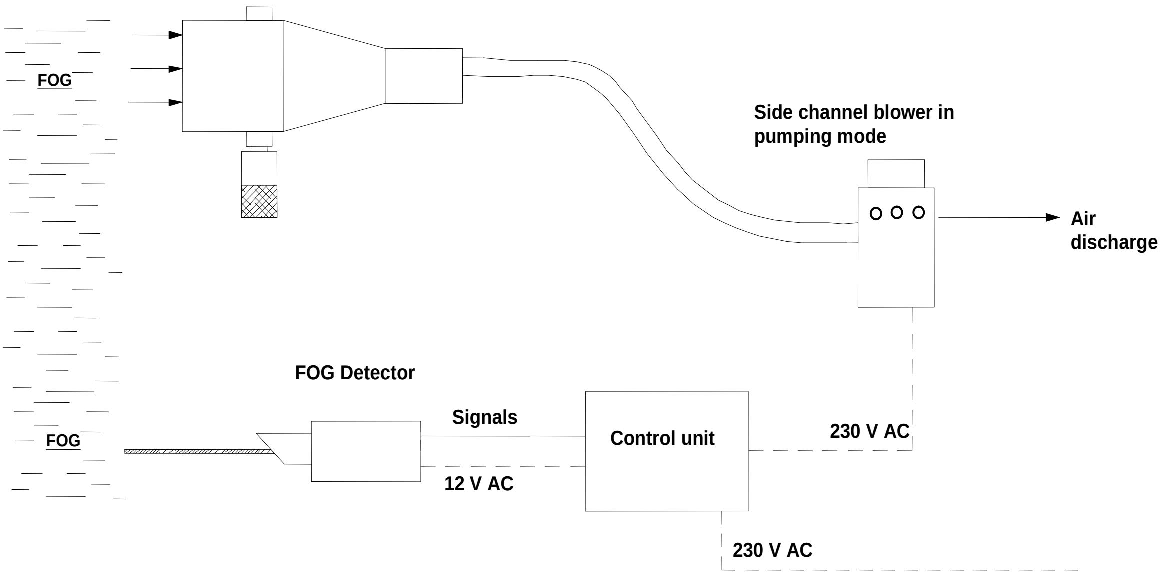
Sample unit	(integrated into housing)
Length x width x height:	360 x130 x 260 mm
Weight:	Approx. 1,9 kg
Sampling orifice:	120 x 120 mm
Operating temperature:	+0…40°C
Collection volume:	250ml (borosilicate glass bottle)
Collection height:	Approx. 1800 mm (including optional stand)
Complete unit	
Length x width x height:	440 x 750 x1090 mm (including shelter and fog sensor)
Weight:	Approx. 70 kg
Connected power	2204230V,50/60Hz, 1300 W

CONTENS OF DELIVERED PROGRAM

Sample unit, integrated
Side channel blower
Thermo-electric cooling/heating system for sample
Rugged housing for outside operation
Fog sensor
Temperature/humidity probe
Documentation

OPTIONS

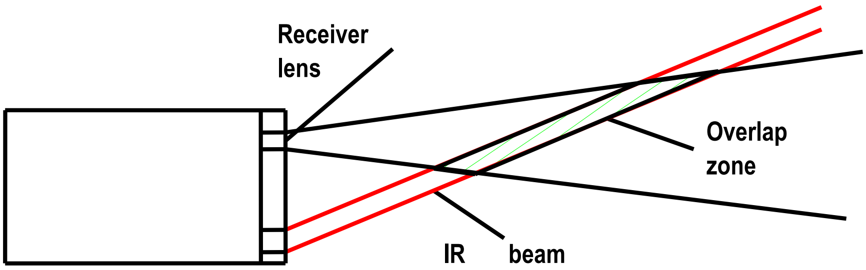
Downgrade for no heating/cooling function for the sample bottle
Extra glass-bottle, 250ml
Data logging with signal PCB memory
Stand base



OPTICAL FOG SENSOR ONED 250

WORKING PRINCIPLE

The ONED 250 is using so called backscatter technique it measures the amount of water particles i e fog in the air that limit the visibility. A narrow beam of IR light comes out of an opening on the front. A detector behind a lens in another opening is sensitive for incoming laser light in a narrow lobe that overlaps the transmitter beam. If there are fog particles in the overlap zone light will be scattered back and reach the detector causing a signal on the sensor raw signal output. The sensitive zone is located about 30 cm ahead of the sensor and its volume is about 1 cubic centimeter.



ELECTRICAL SIGNALS:

The raw signal is analog and it is a measure of the amount of backscattered light from the overlap zone. So the more fog in the overlap zone the more signal.

SIGNAL PROCESSING:

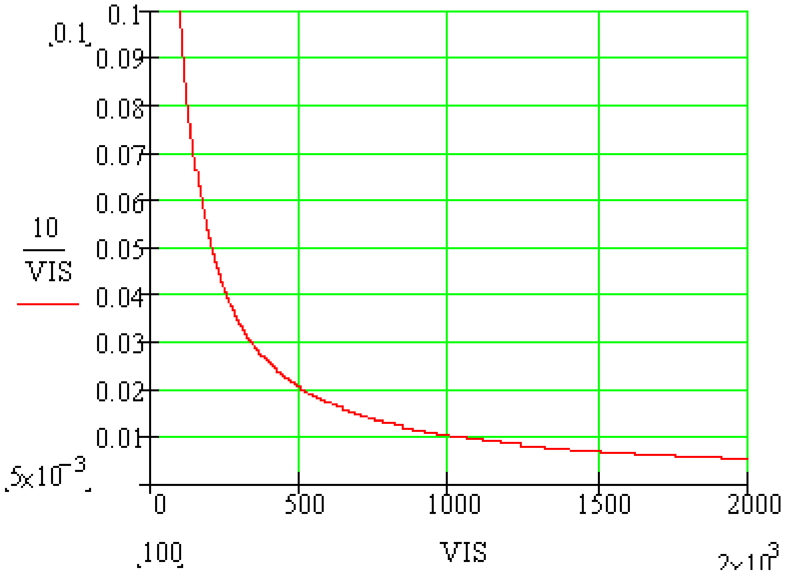
The following expression can be derived for the raw signal V:

Expression 1

$$V = \frac{VIS}{1000} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

V: measured raw signal level
VIS visibility in meters

Where:
V is the measured raw signal level
konst is a calibration constant
VIS is the visibility in meters. The principal relationship between the raw signal output and the visibility, expression (1), above is shown in the following graph, konst is in this case set to 10:



Expression (1) can also be written:

$$VIS = \frac{konst}{V}$$

Expression (2) can thus be used to convert the measured signal V to visibility. If the measured raw signal is too low, lower than noise and temperature drift we can't be sure that there is fog present. Therefore we get an upper limit on the measurable visibility. In the specifications we have set the limit to 5 000 meters. This is somewhat conservative. If the sensor is checked, cleaned and calibrated frequently the limit can be set higher. This also depends on the required accuracy in percent of measured visibility at the higher part of the visibility range. The processed digital output saturate at 10 000 meters visibility but the accuracy is limited above about 5000 meters.
In order to get a value of the visibility as experienced by the eyes, mean values of samples from about one minute from the output are taken and processed. If that is not done very large fluctuations in the signal will occur during fog. The reason is probably that there are spatial variations in the particle density that our eyes can't see.
Microprocessor analysis
The analysis described above is done in an integrated microprocessor. The primary signal is first sampled during one minute and then the calculation according to formula 2 is done.

OUTPUTS

DIGITAL OUTPUTS

The calculated visibility is presented in digital form as an ASCII string on the RS232 output, 2400 baud 8N1, that is transmitted "streaming" every 60 seconds. Polling action can also be delivered as an option. At good visibility the string is typically:

"+0.00000,10000,05200,00005 ".

The first figure is the extinction,
the second is the calculated visibility in meters,
the third figure is a measure of the laser power
and the fourth figure is an uncalibrated measure of the ambient light

The relations between visibility, fog density and extinction are the following:

visibility= 3/extinction.

This string can be received by many loggers with RS232 inputs but also by a PC with a terminal program like Hyper Terminal (part of WIN-98) We recommend a freeware called Br@y terminal.

The microprocessor can as an option control a potential free semiconductor switch that is opened when the calculated visibility is below a certain value (default is 1000 meters). And the switch is closed when the visibility is higher than that value.

MICROPROSSOR CONTROLLED ANALOG OUTPUTS

The microprocessor also controls the analog output giving the visibility directly (VIS =1 km gives 1 Volt, and VIS = 500 meters gives 0.5 Volt etc). If the visibility is larger than 5000 meters the analog output will saturate at 5 Volts .This output is also updated every 60 seconds. During the first minute of operation after switch-on the signal on the analog output will therefore be zero. (This may be a bit confusing at setup)

LOCATION – DIRECTING OF THE SENSOR

The unit should be mounted so that the IR beam is directed approximately **north and horizontal**, i e sunlight must not reach the detector. The beam should not hit anything within a distance of about 10 meters. Some simple shield, protecting the sensor from direct sunlight and the lenses from rain, reaching not more than 100 mm in the laser beam direction helps to keep away precipitation from the optics but in most cases the small shield on the sensor front is sufficient.

RATINGS ONED 250

Connected loads ONED 250

connected load	......	V AC	12 (11…15)
current consumption	......	mA	200
	without heating......	mA	about 60

IR ratings

Wave length	nm	650
Output power......	mW	less 5

Laser safety class......		3R

Warm up time

......	min	1

Area required overall

Minimum (ahead of IR-beam).	approx. m	10

Housing

Dimensions incl. mounted sensor and probe in shelter	mm	120x120x90
Weight overall	approx. kg	1
Protection classification; aluminium housing sealed with O-rings......		IP 65

Visibiltiy range

......	m	20…10000

Signal output

......	V	0..5, analog
......	RS232	2400 baud 8N1

Optional switch that changes state at 1000 meters visibility

Working temperature

......	°C	-20…+50

OPTICAL FOG SENSOR MINI OFS

IN GENERAL

The Mini OFS is a low price sensor for **visibility.** It will work fine for many applications like multi sensor fog warning systems.

The mini OFS is heated to a few degrees above ambient temperature in order to keep moisture away.
In order to keep the electronics dry a membrane ventilator that keeps the pressure inside at the same level as outside. This prevents liquid water from sucking into the sensor through micro cracks etc at falling temperature – a creative solution to a big problem.

The sensor is sensitive for fog particles in a zone about 25 cm ahead of the location of the sensor who limit the visibility in the air. These particles are normally the microscopic water particles constituting fog, but they may also be snowflakes, raindrops or air pollutants. But the most indications of low visibility are because of fog or snow.

The optional available PMMA mounting bracket isolates the sensor electrically which reduces the risk for surge currents

OUTPUTS

ANALOG OUTPUTS

The microprocessor controls the analog output giving the visibility directly (VIS =1 km gives 1 Volt, and VIS = 500 meters gives 0.5 Volt etc up to 4000 meters). If the optical receiver is saturated by for instance sunlight or reflections from an object in the sensitive zone like an insect or fallen snow covering the front the output will be about 5 Volt.

DIGITAL OUTPUTS

The calculated data is presented in digital form as an ASCII string on the RS232 output, 1200 baud 8N1, that is transmitted "streaming" every 30 seconds. This string can be received by many loggers with RS232 inputs but also by a PC via the serial port and with a terminal program like Hyper Terminal (part of WINDOWS).

This is an example of an output string:

amb= 100 alfa=0.0012 VIS= 2500
The first figure – the amb parameter is uncalibrated measure of the ambient solar irradiance in W/m2. The sensitivity depends stongly on how the sensor is aimed. It may vary as much as - 50 to +100%. But the the repitivity is much better and the offset error is only ± 2 units. The sensor can, when mounted, be calibrated by comparing it with an irradiance sensor. But a simple method is to take data from a clear day at noon. If the sun is 60 deg or more above the horizon the irradiance is not far from 1000 W/m2. The measurement is not very accurate- but it may be useful for instance for telling if it is day or night.
The second figure is the so called extinction coefficent often called alfa. The relation between the extinction and visibility is alfa=3/VIS.* The alfa parameter can be used for monitoring trends in visibility when the visibility is larger than 4000 meters. But note that the absolute accuracy in alfa is limited in such cases.
The third figure – the VIS parameter - is the measured visibility in meters
If the optical receiver is saturated by for instance sunlight or reflections from an object in the sensitive zone like an insect or fallen snow covering the front, the visibility displayed visibility value will be 5000 and the output can be:
amb=050 alfa=0.0000 VIS= 5000

RATINGS MINI OFS

Connected loads ONED 250

connected load	V AC	12 (8...14)
current consumption	mA	<50
without heating........	mA	about 60

IR ratings

Wave length	nm	850
Output power........	mW	about 3 from an IR LED-eye safe

Laser safety class........ 1M

Warm up time

....	min	1

Area required overall

Minimum (ahead of IR-beam).	approx. m	10 - 5

Housing

Dimensions	mm	68x45x34
Weight overall	approx. kg	170
Optional: Mounting bracket	PMMA	

Visibiltiy range

....	m	20…4000

Signal output

....	V	0..5, analog
....	RS232	1200 baud 8N1

Working temperature

....	°C	-20…+50