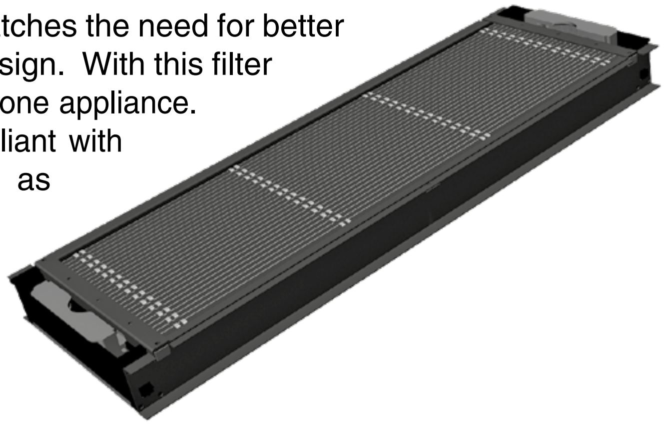
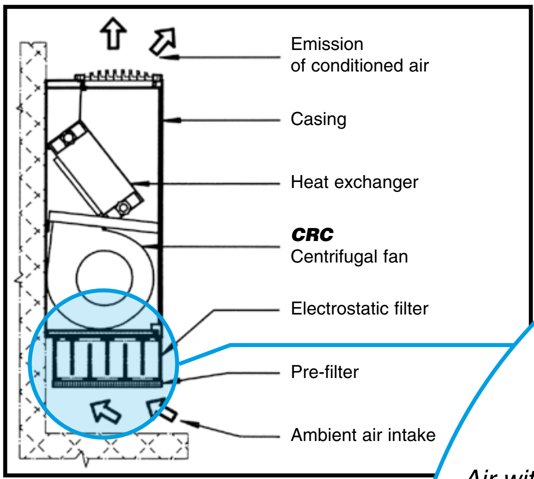
Introduction

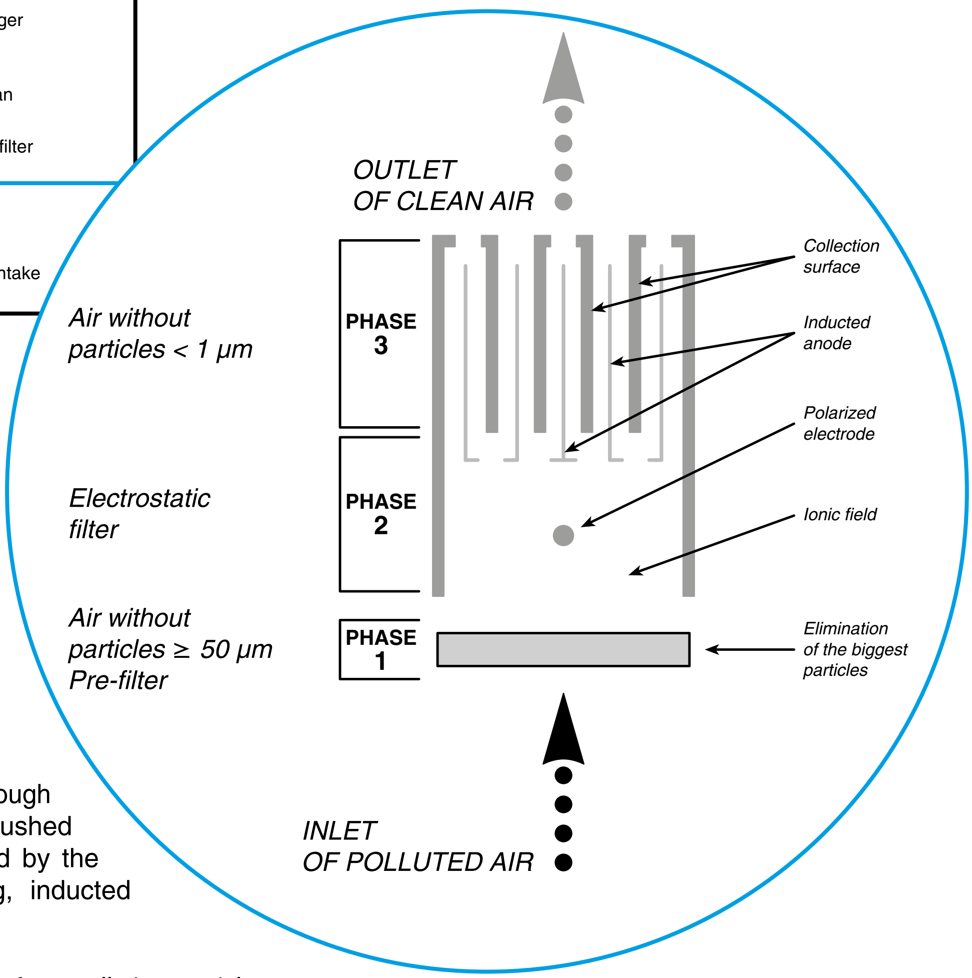
The ***CRYSTALL*** **SABIANA** electrostatic filter matches the need for better air conditioning with the concepts of space and design. With this filter the various stages of air treatment are combined in one appliance. Thanks to this new patented filter (efficiency compliant with new Standard UNI 11254), air pollutants such as cigarette smoke, dust (PM10, PM2.5), pollen and most biological organisms are eliminated.



In addition, as fresh air is not being introduced to obtain the best climatic conditions, there are consequential energy savings.



Operating principle of the ***CRYSTALL*** SABIANA electronic filter



The air is sucked in and first passes a mechanical prefilter, which stops away particles of more than 50 µm (dust, insects, etc.) *(Phase 2).*

Then the smallest particles (50÷0.01 µm) are exposed to an intensive ionic field and are polarized *(Phase 2).*

The charged particles passing through the second filter section, are pushed back by the anode and attracted by the collection surfaces by a strong, inducted magnetic field *(Phase 3).*

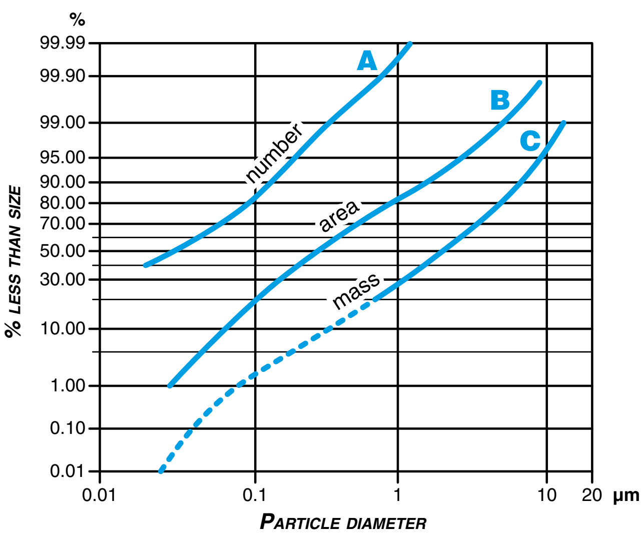
The air which leaves the unit is free from polluting particles.

Indoor air quality (IAQ)

The expression Indoor Air Quality (IAQ) covers all the procedures and methodologies used to **improve the quality of the air we breathe** in the places where we live and work, from all points of view, from temperature to cleanliness, to relative humidity, etc. (EN 15251 and EN 13779). Thanks to its new patented electronic filter, **the *CRYSTALL* electrostatic filter totally eliminates the pollutants present in the air,** including tobacco smoke, dust (PM10, PM2.5), fibres, microbiological substances such as bacteria, fungi, etc., which are harmful to human health (source: OMS 2009).
Purifying the air means not only greater well-being, but also **energy saving,** as the outdoor air changes that are required to restore ideal climatic conditions and that entail greater consumption, are significantly reduced (it is sufficient to enter the quantity of air required to restore the optimum level of CO_2 - source: EN 13779:2007).
Moreover, according to the UNI 10339rev, air recirculated by the ***CRYSTALL*** appliance can be considered as outdoor air, to be added to the minimum requirements (0,5 ls/m^2).
Purifying the air with the Sabiana ***CRYSTALL*** appliance also **entails no reduction of living room space,** as the dimensions of the fan convector are practically unchanged (just 7 cm higher).
The positioning of the electronic filter allows **simple and effective maintenance** and, as it is easy to wash, **its working life is practically unlimited.** The modularity of the filter components and their ease of mounting make the system extremely competitive in terms of cost compared with other types of filters present on the market. In spring and autumn, if environmental air conditioning/heating is not required, the appliance acts simply as an **air purifier.**

The concentration of particles suspended in one litre of air varies from 4.000, in high mountain areas, to 400.000, in a living room environment. The reference unit used to measure the dimensions of a particle is the micron (μm); 1 μm = 0.001 mm.
The graph on the following page shows the distribution of particles according to their size, weight and quantity.
The dimensions and health risks associated with the particles that are most commonly present in the air are indicated in the table on the following page.
The graph on the following page illustrates the filtering capacity of the most common filters, depending on particle size.
As can be seen, the electronic filter is the only filter capable of stopping particles with dimensions less than 1 μm (more than 99% of all the particles present in the air) without altering the appliance air flow (additional load losses are in fact negligible).
Absolute mechanical filters cannot be used on the fan convector, as they create unacceptable load losses.
The electrostatically charged polypropylene filtering fabric (passive Electrete type), sometimes used on some appliances, such as fan convectors or Split System units, has a number of disadvantages: it becomes quickly saturated, it becomes less effective in the presence of high levels of humidity, and its high load losses increase as the filter becomes saturated.

Particle size distribution of atmospheric dust (Source: ASHRAE Handbook Fundamental)

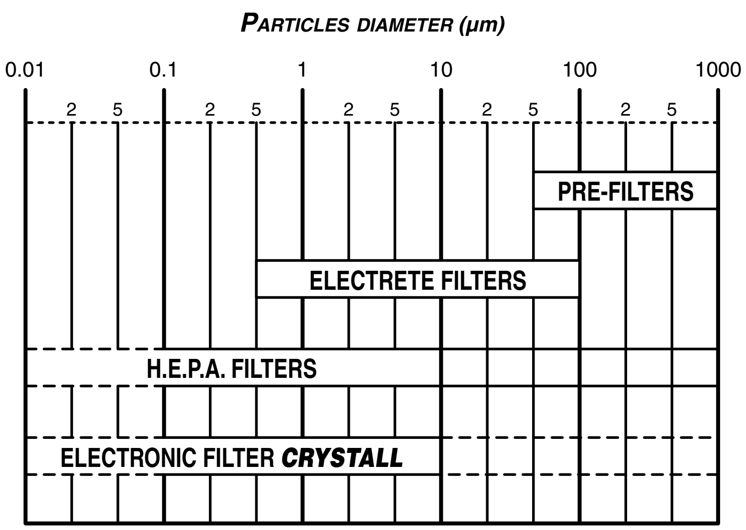


In the diagram there are three different curves that show the particle distribution in accordance to their number (**A**), area (**B**), and mass (**C**). The diagram shows that the 99,9% of the particles in the air is smaller than 1 μm and their mass is only 30% of the total mass. The particles bigger than 1 μm are only 0,1% of the number, but they are 70% of the total mass.

Possible indoor concentration of pollutants and its ratio to their outdoor concentration

Pollutants	Indoor source	Outdoor source	Indoor concentration	Indoor/Outdoor ratio	Environments
Carbon monoxide	fuel-burning equipment, internal combustion engines, defective heating boilers	industrial processes, motor traffic, combustion processes	**100 mg/kg 10-100 ppm**	**>> 1**	houses, offices, shops, cars
Breathable particles	naked flames, cigarettes, sprays, aerosols, kitchen fumes, condensation of volatile substances	combustion, fragmentation of solid substances of animal, vegetable and mineral origin	**0.1-0.7 mg/m^3**	**>> 1**	homes, offices, cars, restaurants, bars, public facilitie
Organic vapours	combustion, solvents, artificial resins, insecticides, aerosols	/ /	**NA**	**> 1**	homes, offices, bars, restaurants, public facilities, hospitals
Nitrogen dioxide	gas ring, water heater, dryer combustion	motor traffic	**0.2-1 mg/m^3**	**>> 1**	homes
Sulphur dioxide	heater burners	heating, motor traffic	**0.02 mg/m^3**		
Total suspended particles without smokers	re-suspension of heating system combustion	/ /	**0.1/1 mg/m^3**	**1**	homes, offices, restaurants, transport vehicles
Sulphates	kitchen rings		**0.005 mg/m^3**	**< 1**	
Formaldehyde	insulation items, plastic resins, furniture finishing	/ /	**0.05/1 mg/kg**	**> 1**	homes, offices
Radon	construction materials, ground, groundwater	/ /	**0.1/200 nCl/m^3**	**>> 1**	cellars, homes, buildings
Asbestos	insulation and cladding	/ /	**$< 10^6$ fibres m^3**	**1**	homes, schools, offices
Mineral and synthetic fibres	plastics, fabrics, carpets, drapes	fragmentation of solid substances	**NA**	**/ /**	homes, schools, offices
Carbon dioxide	combustion, human and animal respiration	/ /	**3 g/kg**	**>> 1**	homes, schools, offices
Micro-organisms	people, animals, insects, plants, fungi, humidifiers, air conditioners, dehumidifiers	pollen, bacteria, virus	**NA**	**> 1**	homes, schools, hospitals, offices

Filtering capacity of the most common filters depending on particle size



Outdoor air according to Standards

EN 13779 and EN 15251 Standards

THE ENVIRONMENTAL CONDITION IS ACCEPTABLE WHEN:

- ***Microclimatic parameters are normal***
- ***80% of people are satisfied by the quality of air***
- ***Specific internal contaminants are not in harmful concentrations***

The simplest way to obtain the required air quality is to dilute the pollutants present with outdoor air.
The quantity and quality of outdoor air required is indicated in the european EN 13779 and EN 15251 Standards.

Category	Unit	Rate of outdoor air per person			
		No smoking areas		Smoking areas	
		Typical range	Default value	Typical range	Default value
IDA 1	$l.s.^{-1}$ $person^{-1}$	> 15	20	> 30	40
IDA 2	$l.s.^{-1}$ $person^{-1}$	10 – 15	12,5	20 – 30	25
IDA 3	$l.s.^{-1}$ $person^{-1}$	6 – 10	8	12 – 20	16
IDA 4	$l.s.^{-1}$ $person^{-1}$	< 6	5	< 12	10

As can be easily understood, the more outdoor air is brought into the environment the more energy costs increase to achieve ideal climatic conditions.

Outdoor air according to Standards

EN 13779:2007 and UNI 10339rev Standards

The example reproduced at the bottom of the page shows how, with adequate air filtering, it is possible to decrease considerably the quantity of outdoor air to be brought into the environment (up to 4-5 times less); the thermal energy dissipated due to ventilation is in fact in direct proportion to the number of air changes, as indicated in the following equation:

$$Qv = \Delta T \cdot \frac{R}{3600} \cdot D \cdot C \cdot Vol.$$

Qv = Thermal energy lost for ventilation - Watt
ΔT = Indoor-Outdoor difference (T) - °C
R = A.C.H.
D = Air density - Kg/m^3
C = Specific air heat - J/Kg-°C
Vol = Room size - m^3

Example of energy saving in accordance to the new Standard

MSR: Minimum Supply Rate (m^3/h/pers.) *(design method - indirect classification)*
DVR: Design Ventilation Rate (m^3/h/pers.) *(performance method)*

When the minimum outdoor air flow is lower than the minimum supply rate (**DVR<MSR**), is possible to use a recirculating air system to integrate and satisfy the requested quantity.

Vsec = 100 · (MSR – DVR) / Ef (m^3/h)

Vsec: filtered recirculated air (SEC)
Ef: (%) filter efficiency for particles (PM10 or PM2,5)

EXAMPLE: Parameters assumed are:

Office space:

Ab = area 20 m^2
Rb = 1,44 m^3/h per m^2 (UNI 10339rev and EN 15251 Standards)

N° of people:

Pd = n° 2
Rp = 25.2 m^3/h per person (UNI 10339rev and EN 15251 Standards)
D = 1

Where:
Ab: building area
Rb: minimum outdoor air per building component
Pd: number of people (occupant)
Rp: minimum outdoor air per person
D: Diversity factor

Design method (indirect classification):

MSR = (Rp · Pd · D) + (Rb · Ab) = (25.2 · 2 · 1) + (1,44 · 20) = 79,2 m^3/h
(the check that this value is ≥ 36 m^3/h per person is positive)

Performance method:

DVR = Rb = 1,8 m^3/h for m^2 (≥0.5 l/s/m^2 from UNI 10339rev EN 13779 paragr. 6.2.5.5)
Ef = minimum **80%** on **PM2.5** (UNI 11254 class D-PE)

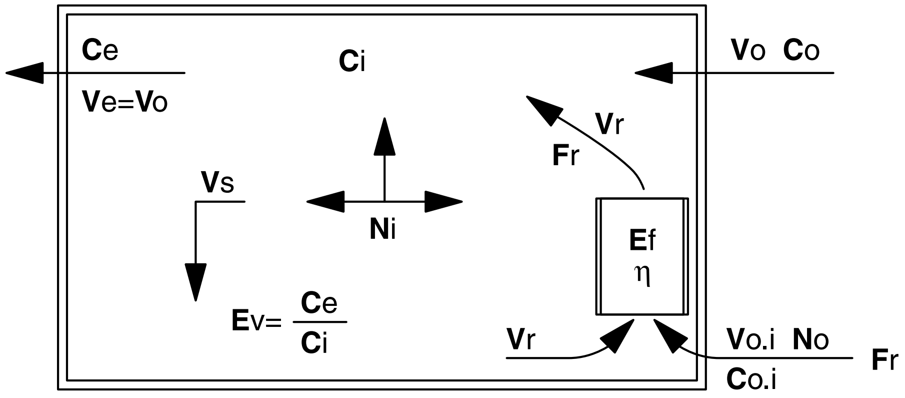
Vsec = 100 · (MSR – DVR) / Ef = 100 · (79.2 - 36) / 80 = 54 m^3/h **recirculated air (SEC)**

then we will have, as calculated:

- **36** m^3/h outdoor air (1,8 · 20 - UNI 10339rev)
- **54** m^3/h filtered secondary air - SEC (80%)

Therefore, installing a secondary air system with the ***CRYSTALL*** SABIANA electronic filter, the energy saving that can be achieved is remarkable.
In fact, only 36 m^3/h of outdoor air is necessary, instead of 79.2 m^3/h in case of total fresh air intake in accordance to EN 13779:2007 Standard.

System type

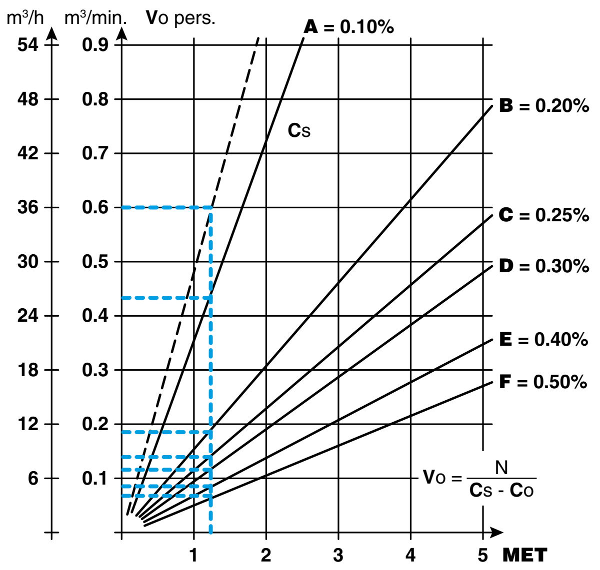


Ce = Contaminate concentration (exhaust air flow) µg/m³
Co = Contaminate concentration (outdoor air) µg/m³
Ci = Contaminate concentration (indoor air) µg/m³
Ef = Filter effectiveness (η) %
Ev = Ventilation effectiveness (Ce/Ci) 0 to 1
Fr = Flow reduction factor 0 to 1
Ni = Contaminant generation rate (indoor) (x pers. or m³) µg/min.
No = Contaminant generation rate (outdoor) µg/min.
Ve = Exhaust air flow m³/min.
Vo = Outdoor air flow m³/min.
Vs = Supply air flow (Vr + Vo) m³/min.
Vr = Return air flow m³/min.
Vol = Building size m³

$$Vr = \frac{Ni - Vo \cdot Ev\,(Ci - Co)}{Fr \cdot Ev \cdot Ef \cdot Ci} \qquad Ci = \frac{Ni + Ev \cdot Vo \cdot Co}{Ev \cdot (Vo + Vr \cdot Ef \cdot Fr)}$$

To size ***CRYSTALL*** filters and their number, we recommend to use the spreadsheet *"Calculating IAQ ver. 1.7a"* available from Sabiana S.p.A. and from the site www.sabiana.it.

CO_2 room concentration with different outdoor air flows



Cs	= 1000	ppm	= 26	m³/h	person	(**Vo**)	(**A**)
	= 2000	"	= 11	m³/h	person	"	(**B**)
	= 2500	"	= 8.5	m³/h	person	"	(**C**)
	= 3000	"	= 7	m³/h	person	"	(**D**)
	= 4000	"	= 5	m³/h	person	"	(**E**)
	= 5000	"	= 4	m³/h	person	"	(**F**)

Example
of the concentration of CO_2
with a phisical activity of 1.2 MET.

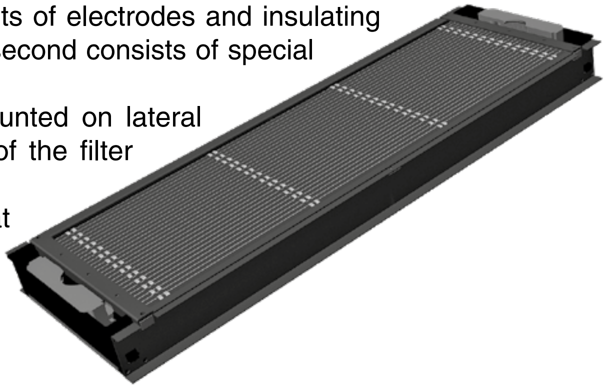
(1 MET = 18.4 BTU/h per Ft²)

Construction features of ***CRYSTALL***

The ***CRYSTALL*** electronic filtering system consists of two parts: the first is a **plate type electronic active filter** and is fitted in the suction section of the fan convector, while the second is an **electronic control and regulation board.**
All electrical connections are made during production. The installation of the **Carisma** fan convector incorporating the ***CRYSTALL*** electronic filter is therefore similar to that of a normal fan convector; the only difference is the installation height, for which the filter dimensions must taken into account.
CRYSTALL may be installed on the **entire range and on all versions of the Carisma fan convector.**

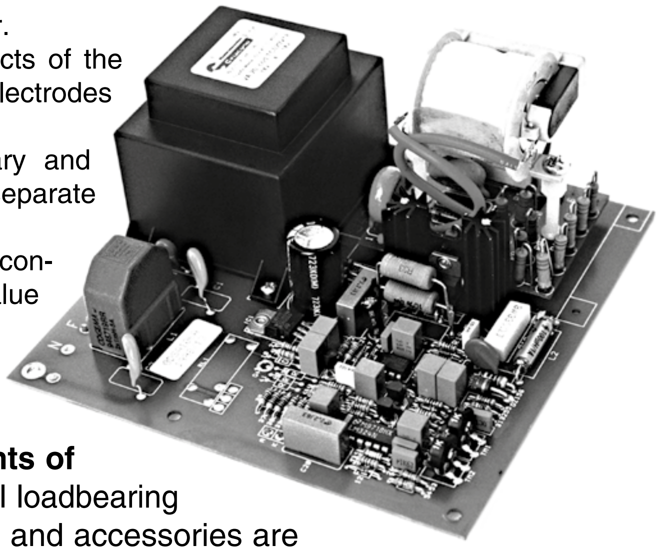
Active plate type electronic filter

The filtering element consists of two sections: the first consists of electrodes and insulating elements, forming a self-supporting ionising frame, while the second consists of special reliable and light aluminium sheet (collector).
The two sections are installed in an extractable drawer mounted on lateral telescopic guides to make the extraction and maintenance of the filter easier.
The extraction of the drawer actuates a safety microswitch that cuts off the voltage supply to the electrodes.
The collector can be cleaned by washing with water and ordinary detergents or steam jets (please consult the maintenance manual for further details).



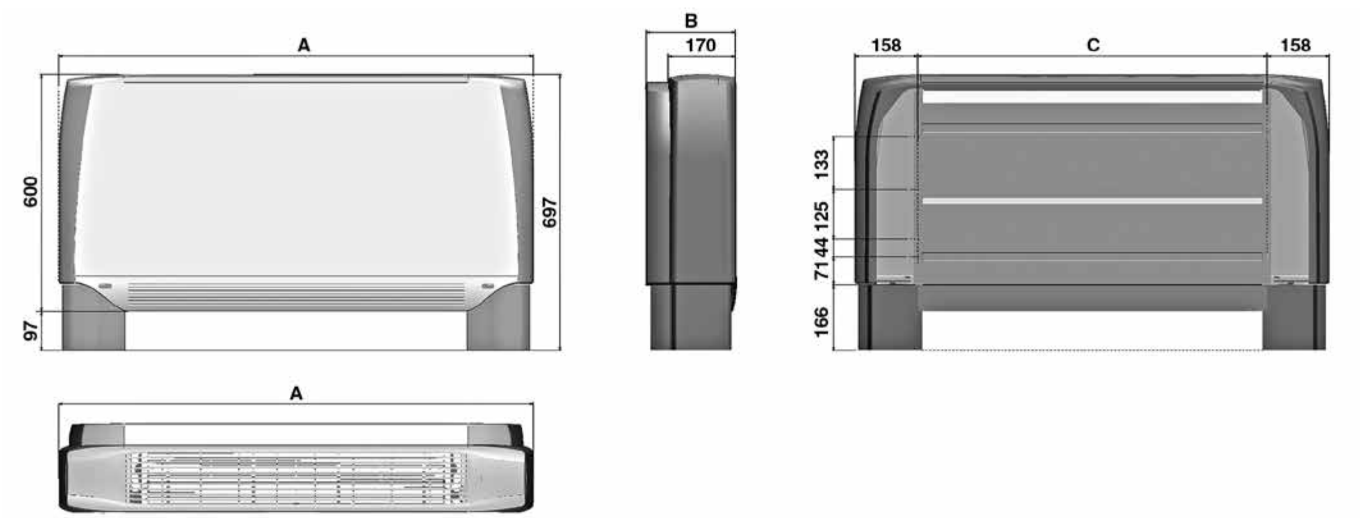
Electronics board

Controls and regulates all functions of the electronic filter.
It is appropriately protected against any operating defects of the electronic filter. It supplies a constant voltage to the electrodes when the mains supply voltage varies (± 15%).
The supply transformer is constructed with its primary and secondary coils physically separated and wound onto separate cores.
The energy consumption depends on the size of the fan convector on which the filter is mounted, with a maximum value of about 0,015 kW.



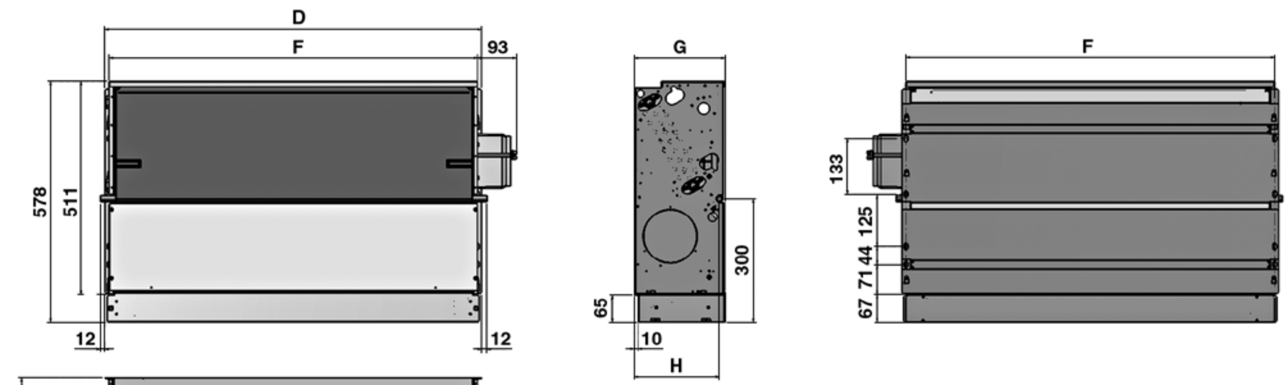
The technical features of the various components of the fan convector, such as the casing, the internal loadbearing structure, the mechanical filter, the ventilating unit and accessories are described in this catalogue in the parts referring to the ***CRC range*** (centrifugal fan). The control and regulation controls are described instead on page “Control functions” and the following pages.

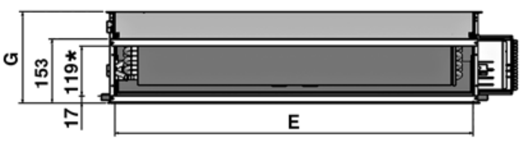
MV



Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A (mm)	670	770	985	985	1200	1200	1415	1415	1415
B (mm)	225	225	225	225	225	225	225	255	255
C (mm)	354	454	669	669	884	884	1099	1099	1099

IV-IO

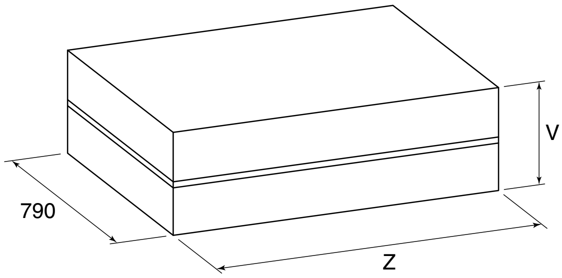




* Supply frame dimension = ***E*** x ***119 mm***

Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
D (mm)	374	474	689	689	904	904	1119	1119	1119
E (mm)	330	430	645	645	860	860	1075	1075	1075
F (mm)	354	454	669	669	884	884	1099	1099	1099
G (mm)	218	218	218	218	218	218	218	248	248
H (mm)	205	205	205	205	205	205	205	235	235

PACKAGING



Dimension (mm) – *MV / IV-IO model*

MODEL	1	2	3	4	5	6	7	8	9
V	280	280	280	280	280	280	280	310	310
Z	690	790	1005	1005	1220	1220	1435	1435	1435

Weight (kg) – *MV model*

		Weight with packaging									Weight without packaging								
MODEL		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Rows	3	19	21	27	28	33	34	39	43	44	17	19	24	25	30	31	35	38	39
	3+1	20	24	33	34	39	40	46	51	52	18	22	30	31	36	37	42	46	47
	3+2	20	27	39	40	45	46	53	59	60	18	25	36	37	42	43	49	54	55
	4	19	23	30	31	36	37	43	49	50	17	21	27	28	33	34	39	44	45
	4+1	20	26	35	36	41	42	49	56	58	18	24	32	33	38	39	45	51	53

Weight (kg) – *IV-IO model*

		Weight with packaging									Weight without packaging								
MODEL		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Rows	3	15	20	27	28	33	34	38	41	41	13	18	24	25	30	31	34	36	36
	3+1	16	23	32	33	38	39	44	48	49	14	21	29	30	35	36	40	43	44
	3+2	17	26	37	38	43	44	50	55	57	15	24	34	35	40	41	46	50	52
	4	16	22	29	30	35	36	41	46	47	14	20	26	27	32	33	37	41	42
	4+1	17	25	34	35	40	41	47	53	55	15	23	31	32	37	38	43	48	50