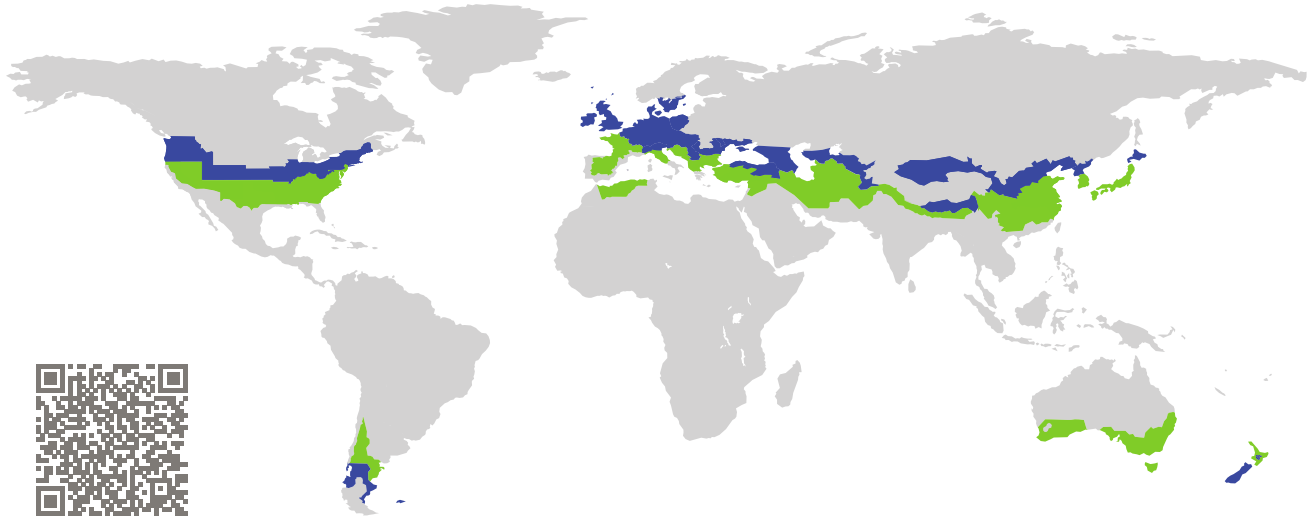


CERTIFICATE

Certified Passive House Component

Component-ID 0702vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir180 (V) HRV, ComfoD180 (V) HRV**

Specification: Airflow rate <math>< 600 \text{ m}^3/\text{h}</math>
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{\text{HR}} \geq 75\%$
Specific electric power $P_{\text{el,spec}} \leq 0.45 \text{ Wh/m}^3$
Leakage $< 3\%$

Comfort Supply air temperature $\geq 16.5\text{ }^\circ\text{C}$
at outdoor air temperature $-10\text{ }^\circ\text{C}$

Airflow range
90–145 m ³ /h
Heat recovery rate
$\eta_{\text{HR}} = 82\%$
Specific electric power
$P_{\text{el,spec}} = 0.27 \text{ Wh/m}^3$

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of *10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 82\%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.27 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.64$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
1.05 %	0.95 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 90–145 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 4.50 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 142 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
43.0 dB(A)	41.2 dB(A)	52.4 dB(A)	43.7 dB(A)	53.1 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

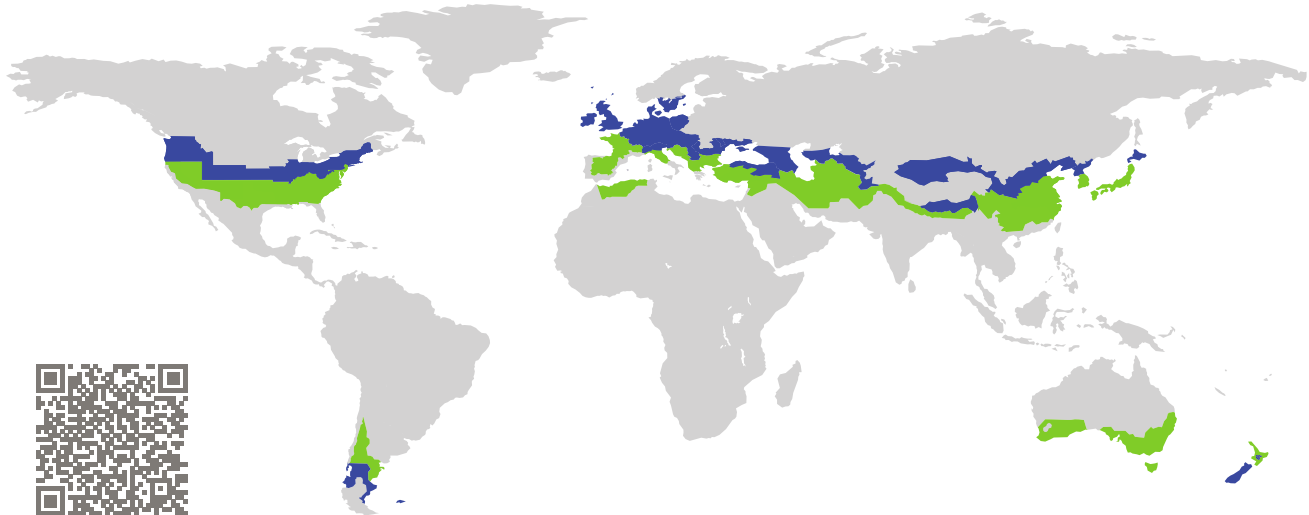
- Frost protection of the heat exchanger:
 - ✓ The manufacturer provides the device option V that is already equipped with an internal electric preheater with a maximum power of 1150 W. The frost protection strategy is based on the outdoor air temperature behind the preheater. For the operation of the frost protection strategy the frost protection mode 2 "normal settings" is recommended which complies with the preset factory settings. It is also possible to install units without internal preheater. In this case an adequate external frost protection strategy must be installed.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic supply air heater, an undershooting of 5°C supply air temperature leads to a shutdown of the supply air fan.

CERTIFICATE

Certified Passive House Component

Component-ID 0326vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.
Netherlands**
Product name: **ComfoAir160 HRV, ComfoD160 HRV,
ComfoD150 HRV**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
73–109 m ³ /h
Heat recovery rate
$\eta_{HR} = 89\%$
Specific electric power
$P_{el,spec} = 0.36 \text{ Wh/m}^3$

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is main tained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 89\%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.36 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.67$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
2.37 %	1.49 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 73–109 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device being tested can't be switched off and does not provide a standby modus. The device must be equipped with an external switch to disconnect it from the electric power supply if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 113 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
52.9 dB(A)	33.3 dB(A)	61.1 dB(A)	39.1 dB(A)	59.7 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

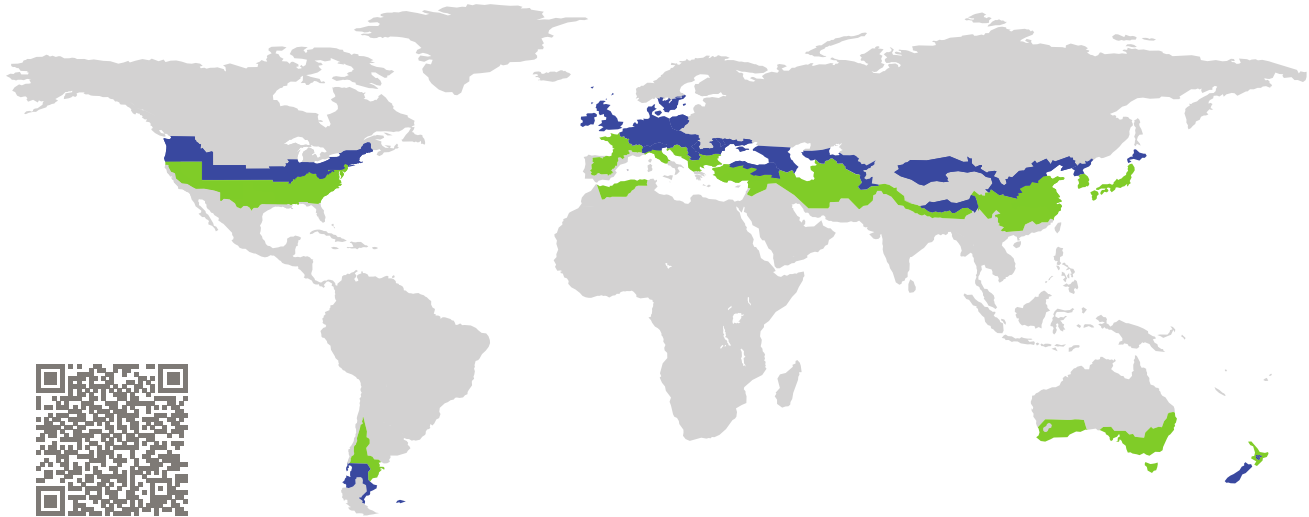
- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing, the unit could be equipped optionally with an electrical preheater with a power output of up to 700 W at the upper air flow rate. This frost protection strategy (operating mode 2) is appropriate to protect the heat exchanger from frost down to an outdoor air temperature of -15°C (verified by measurement results). The frost protection strategy starts operating at an outdoor air temperature of -6°C .
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic supply air heater, an undershooting of 4.2°C supply air temperature leads to a shutdown of the unit. In this case the display will show an error.

CERTIFICATE

Certified Passive House Component

Component-ID 0327vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir200, ComfoD250, WHR920**

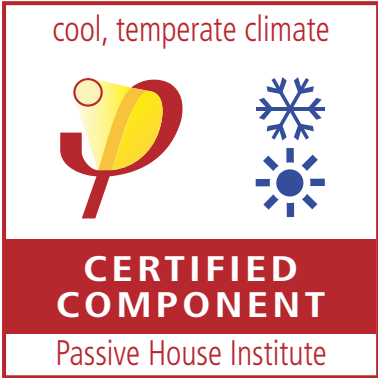
Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
60–150 m ³ /h
Heat recovery rate
$\eta_{HR} = 92\%$
Specific electric power
$P_{el,spec} = 0.42 \text{ Wh/m}^3$



Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 92\%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.42 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.67$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
2.84 %	0.80 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 60–150 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 6.10 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 150 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
49.0 dB(A)	64.7 dB(A)	57.2 dB(A)	54.1 dB(A)	67.1 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

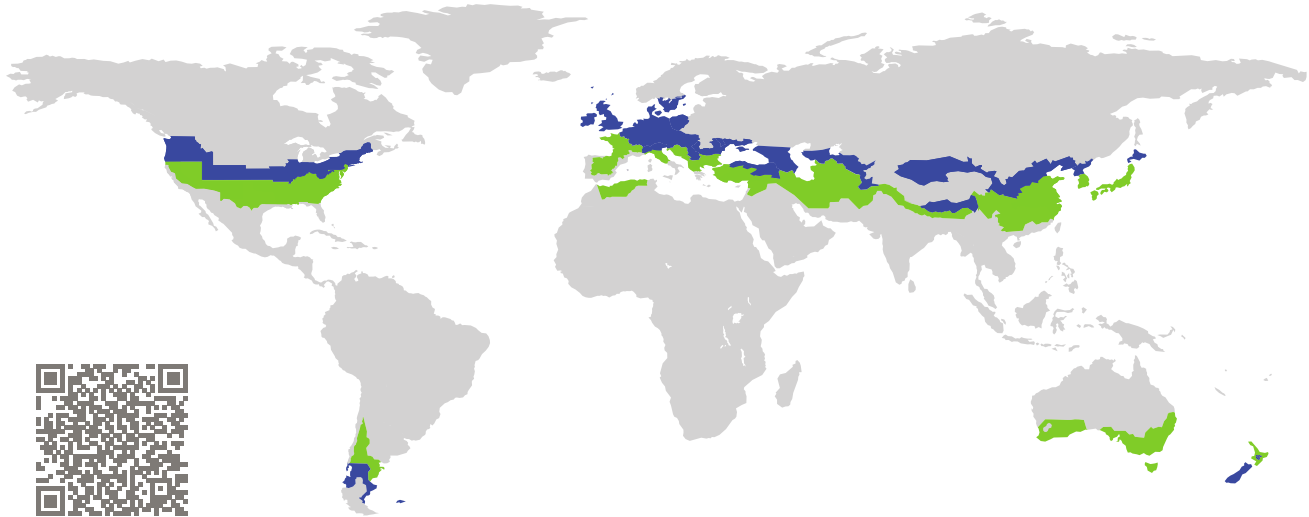
- Frost protection of the heat exchanger:
 - ✓ In order to guarantee safe operations of the device also at low outdoor air temperatures without reducing the supply air flow rate, the manufacturer recommends either an internal or external preheating coil. Therefore the manufacturer provides the optional electric preheating coil HRI 40 20 with a heating power of 900 W. In case of a subsequent installation the frost protection component is also available as an installation kit.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic heater coil the device is switched off as soon as the supply air temperature falls below 5°C . In this case the display will show an error.

CERTIFICATE

Certified Passive House Component

Component-ID 0328vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir350, ComfoD350, WHR930**

Specification: Airflow rate <math>< 600 \text{ m}^3/\text{h}</math>
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage $< 3\%$

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
71–293 m ³ /h
Heat recovery rate
$\eta_{HR} = 84\%$
Specific electric power
$P_{el,spec} = 0.29 \text{ Wh/m}^3$

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in Wh/(kg K)

Heat recovery rate

$$\eta_{HR} = 84 \%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.29 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.65$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
1.50 %	1.90 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 71–293 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device being tested can't be switched off and does not provide a standby modus. The device must be equipped with an external switch to disconnect it from the electric power supply if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 290 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
54.1 dB(A)	50.1 dB(A)	63.8 dB(A)	50.2 dB(A)	61.4 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

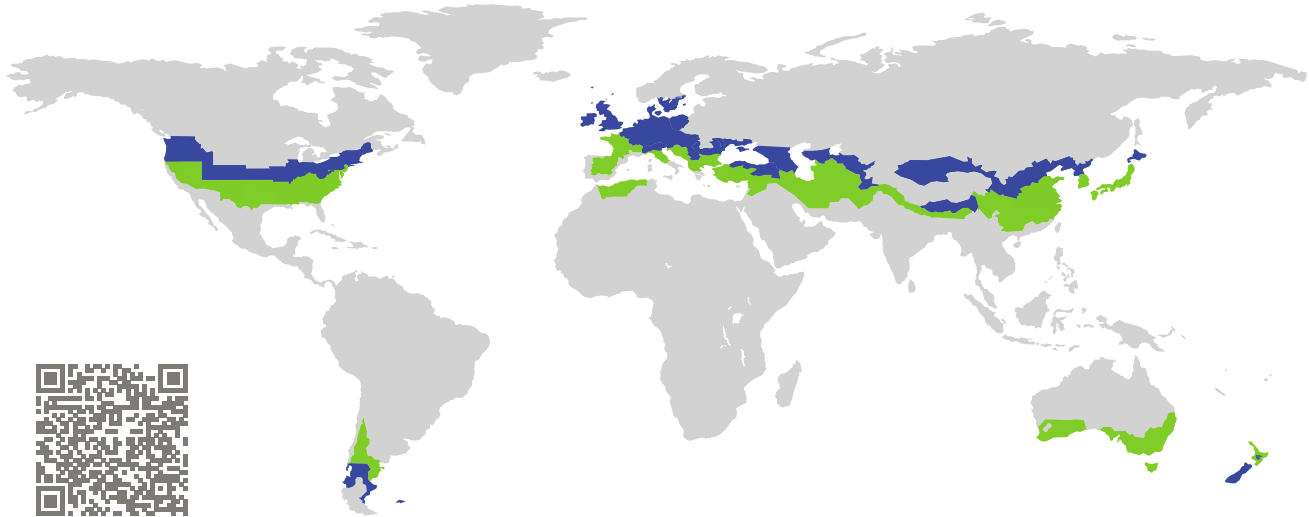
- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing, the unit could be equipped optionally with an electrical preheater if no ground heat exchanger is installed. The standard internal frost protection strategy without a preheating coil is based on defrosting by imbalance and therefore is not suitable for passive houses. For operation in passive houses an electrical preheater is necessary. Alternatively a ground or brine heat exchanger is recommended.
- Frost protection of downstream hydraulic heater coils:
 - ✓ The frost protection shutdown has not been tested within the scope of the laboratory measurements. However according to manufacturer documentation the device provides this function as soon as the supply air temperature drops below 5°C .

CERTIFICATE

Certified Passive House Component

Component-ID 0329vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir550, ComfoD550, WHR960**

Specification: Airflow rate <math>< 600 \text{ m}^3/\text{h}</math>
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage $< 3\%$

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
110–308 m ³ /h
Heat recovery rate
$\eta_{HR} = 84\%$
Specific electric power
$P_{el,spec} = 0.31 \text{ Wh/m}^3$

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 84 \%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.31 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.64$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
1.02 %	0.61 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 110–308 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 1.60 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 442 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
48.1 dB(A)	44.8 dB(A)	47.6 dB(A)	48.2 dB(A)	47.6 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

- Frost protection of the heat exchanger:
 - ✓ A preheater coil with an electrical power output of about 1000 W (1200 W at 400 V electric supply) is preinstalled in the device. The additional internal frost protection (imbalance by reducing the outdoor air flow rate) is not suitable for passive houses. In order to guaranty all functions of the units at the upper air flow rate even at outdoor airtemperatures of -15°C , the manufacturer recommends the installation of either a ground heat exchanger or the additional preheater coil "iso-Defrosterheizung" with a max. power of about 2000 W.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic heater coil in the supply air duct from freezing the unit is switched off as soon as the supply air temperature drops below 5°C .

Certificate

Certified Passive House Component

For cool, temperate climates, valid until 31 December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY



Category: **Heat recovery unit**
Manufacturer: **Zehnder Group AG**
Paul Wärmerückgewinnung GmbH
08141 Reinsdorf, GERMANY
Product name: **ComfoAir 70 with second room connection**

This certificate was awarded based on the following criteria:

Thermal comfort	$\theta_{\text{supply air}} \geq 16.5 \text{ °C}$ at $\theta_{\text{outdoor air}} = -10 \text{ °C}$
Effective heat recovery rate	$\eta_{\text{HR,eff}} \geq 75 \%$
Electric power consumption	$P_{\text{el}} \leq 0.45 \text{ Wh/m}^3$
Airtightness	Interior and exterior air leakage rates of 3 % of nominal air flow rate met
Balancing and adjustability	Air flow balancing possible: yes Automated air flow balancing: no
Sound insulation	Sound pressure level in functional rooms $\leq 30 \text{ db(A)}$
Indoor air quality	Outdoor air filter at least F7 Extract air filter at least G4
Frost protection	frost protection for the heat exchanger with continuous fresh air supply down to $\theta_{\text{outdoor air}} = -15 \text{ °C}^{2)}$

- 1) The required sound pressure level in the installation room can be exceeded in demand operation mode.
- 2) Frost protection strategy suitable for outdoor air temperatures down to -10°C .

Further information can be found in the appendix of this certificate.

Certified for air flow rates of

15 - 25 m³/h
(continuous operation)

15 - 40 m³/h¹⁾
(on-demand operation)

$\eta_{\text{HR,eff}}$
85 %

Average moisture recovery
 $\eta_x = 0,64$

Electric power consumption
0.24 Wh/m³



CERTIFIED COMPONENT

Passive House Institute

Appendix Zehnder Group AG, Paul Wärmerückgewinnung GmbH, ComfoAir 70

Manufacturer: Zehnder Group AG, Paul Wärmerückgewinnung GmbH
 August-Horch-Straße 7, 08141 Reinsdorf, GERMANY
 Tel: +49 (0) 375 303505 - 0
 E-Mail: info@paul-lueftung.de, www.zehnder-systems.com

Moisture recovery

By means of moisture recovery the indoor air humidity can be higher than without moisture recovery. Especially during the winter months that could lead to reduced heating demand caused by less evaporation of water from construction components and furniture. This energy relevant influence is considered, depending on the moisture recovery rate, with a bonus on the heat recovery rate of the ventilation device.

- Adjustment of air flow by means of moisture control:
 - This ventilation slightly exceeds a moisture recovery rate > 0.6. In order to prevent damage from occasional excessive humidity, a humidity controlled air flow control is recommended.
 - The device being tested does not provide such a function.
- Application of moisture recovery:
 - In cool temperate climates, heat exchanger with moisture recovery in general should only be used if the internal moisture load of the building is low compared to normal utilization (e.g. residential building with occupancy rate (far) below average).
 - If planning the application of moisture recovery in building with average occupancy rate, the energy balance of the building is to be calculated with an increased air flow rate according to following formula.

$$\dot{V}_{eff} = \dot{V}_{hyg} \cdot \frac{0,4}{1 - \eta_x}$$

- Adjustment of air flow by means of moisture control required, even though that in case of low internal moisture the increased air flow rate is not needed often.

Passive House comfort criterion

Temporarily lower supply air temperatures (14 °C) might occur due to the type of heat exchanger and frost protection strategy. Once the frost protection is active, the supply air temperature increases again to more than 16.5 °C.

Efficiency criterion (heat recovery rate)

The effective dry heat recovery rate is measured at the test facility using balanced mass flows on the outdoor air/extract air side. The boundary conditions for the measurement should be taken from the documents relating to the testing procedure.

$$\eta_{WRG,eff} = \frac{(\mathcal{G}_{Ab} - \mathcal{G}_{Fo}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\mathcal{G}_{Ab} - \mathcal{G}_{Au})} + 0,08 \cdot \eta_x$$

Annotation: For moisture recovery $\eta_x > 0,6$ the bonus is limited to a maximum of 4.8 %.

Appendix Zehnder Group AG, Paul Wärmerückgewinnung GmbH, ComfoAir 70

The (dry) ventilation heating load (the house is the system boundary) can be calculated using $\eta_{HR,eff}$ based on the formula $\dot{V}_{supply} * (1 - \eta_{HR,eff}) * 0.34 * \Delta\theta$ (multiplied by the infiltration rate). The rates of heat recovery are usually greater if condensation occurs in the heat exchanger. Initially, this will not be taken into account on purpose.

For this device:

$$\eta_{HR,eff} = 85 \%$$

Efficiency criterion (power consumption)

The unit was examined with the following conditions, which are according to a standard installation situation of the unit. Outdoor air and exhaust air free air intake and discharge, -extract air free air intake, supply air with duct connection (Pressure difference 50 Pa)

For this device:

$$0.24 \text{ Wh/m}^3$$

Air tightness and insulation

Before starting the thermodynamic test, the device was tested respecting internal and external leakages. The leakage air flows must not be greater than 3 % of the average air flow volume of the operating range of the ventilation device.

The following result was obtained for the device being tested at an external pressure difference of 50 Pa:

Internal leakage: 0.64 %

External leakage: 1.88 %

Adjustability

It must be possible to adjust the balance between the exhaust air flow rate and the outdoor air flow rate for all units.

- This unit is certified for air flow rates of **15 - 25 m³/h** (continuous operation) or **15-40 m³/h** (on-demand operation)
- Balancing the air flow rates of the unit is possible
- The device being tested here has a standby power consumption of **3 W** and therefore does not comply with the target value of 1 W. The device should be equipped with an additional external switch to separate the device from the electric circuit if required.
- After a power failure the device automatically continues to operate in the mode that was set before the power failure. The unit should be equipped with an additional switch.

Acoustical testing

Since it can be assumed that the unit will be installed in a functional or secondary room the sound pressure level should be restricted to 30 db(A). The following sound levels for the unit with second room connection have been determined depending on the air flow rate.

Air flow rate [m ³ /h]	15	25	40	65
Sound level unit Lw [dB(A)]	25.7	31.6	43.6	54.4

Appendix Zehnder Group AG, Paul Wärmerückgewinnung GmbH, ComfoAir 70

The criteria for the sound pressure level (30 dB(A)) in the specific installation room with an equivalent room absorption area of 10 m² are met for the unit with second room connection up to an air flow rate of 25 m³/h (continuous operation).

Indoor air hygiene

Inspection and cleaning of the central device including the heat exchanger is simple. The filter can be replaced by the user himself/herself (no specialist required). The unit is equipped with following filter qualities:

- Outdoor Air filter G4
- ✓ Extract Air filter G4

As standard the unit is equipped with G4 filter at the extract and supply air side. For the installation in a Passive House the unit should be equipped with an Outdoor Air filter F7 (available as an accessory from manufacturer)

If the device is not operated during the summer, the filter should be replaced before the next operation.

Frost protection

Appropriate measures should be taken to ensure prevention of icing over of the heat exchanger and freezing up of hydraulic post-heater coils during extreme winter temperatures (-15 °C). The regular functioning of the device should be permanently ensured during uninterrupted operation of the frost protection circuit (the interruption of the outdoor air flow is no adequate frost protection strategy for passive houses, as the heating loads caused by the forced infiltration would become too high).

- Frost protection circuit for the heat exchanger:
 - ✓ The frost protection strategy is based on reducing the supply air flow rate depending on the outdoor air temperature. The frost protection strategy, due to the type of heat exchanger with moisture recovery, starts operation at rather low outdoor air temperatures (start of frost protection during the laboratory test at -8.2 °C). Down to an outdoor air temperature of -10 °C, the imbalance is ≤ 25%. Lower outdoor air temperatures will cause higher imbalances and will finally lead to a supply air shut down (at about -13 °C).

Abbreviations

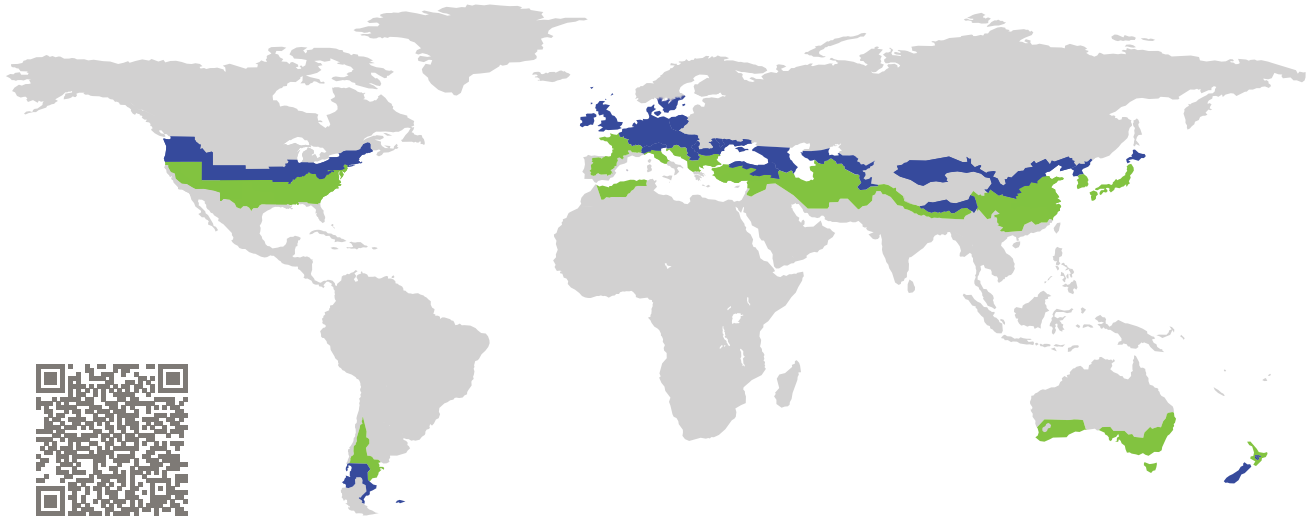
- AU/ODA = Outdoor air
- FO/EHA = Exhaust air
- ZU/SUP = Supply air
- AB/ETA = Extract air

CERTIFICATE

Certified Passive House Component

Component-ID 0956vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir Q350 HRV, Comfort Vent Q350 HRV**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
70–270 m ³ /h
Heat recovery rate
$\eta_{HR} = 90\%$
Specific electric power
$P_{el,spec} = 0.24 \text{ Wh/m}^3$

- At an airflow of 138 m³/h, a heat recovery of $\eta_{HR} = 91\%$ is reached.
- Due to the frost protection strategy at outdoor temperatures of -15°C the air flow rate is reduced to about 200 m³/h.

cool, temperate climate



CERTIFIED COMPONENT

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 90 \%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.24 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.73$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
0.27 %	0.28 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 70–270 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 1.30 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 273 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
43.0 dB(A)	39.2 dB(A)	52.1 dB(A)	39.2 dB(A)	51.6 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures ($-15\text{ }^{\circ}\text{C}$). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

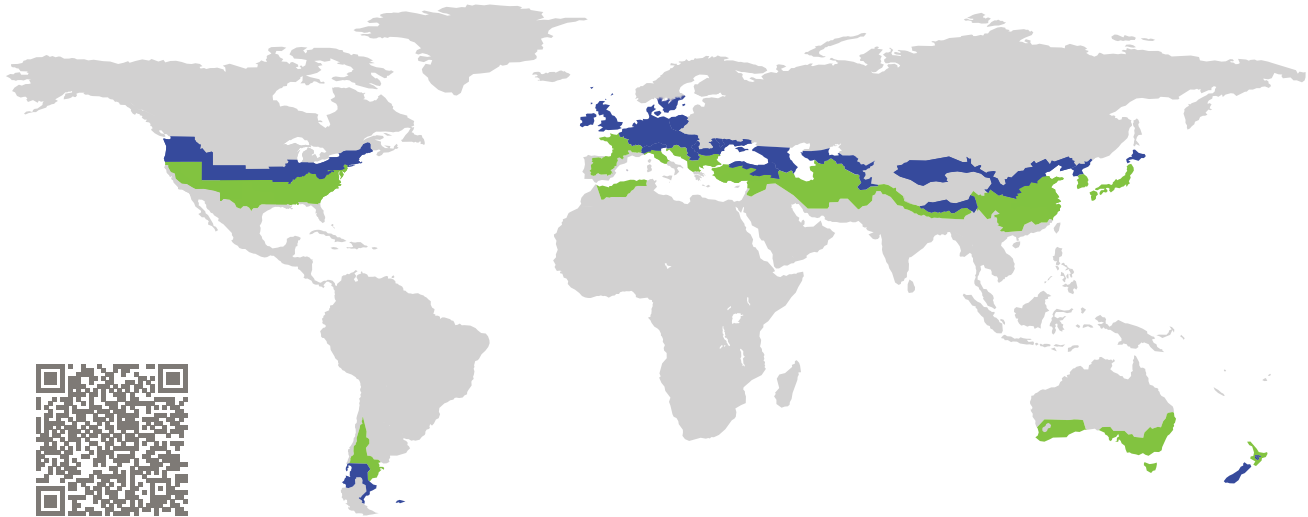
- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing, the unit can optionally be equipped with an electrical preheater of 1.7 kW. The pre heating power is controlled depending on the outdoor air- and supply air temperature. In the measurement the preheater was activated at an outdoor air temperature of $-8.7\text{ }^{\circ}\text{C}$. Due to the frost protection strategy, the air flow rate will be reduced to about $200\text{ m}^3/\text{h}$ at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$. In order to ensure the upper air flow rate of $270\text{ m}^3/\text{h}$ even at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$, an additional preheater power or a post-heater is recommended.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic heater coil the device is switched off as soon as the supply air temperature falls below about $10\text{ }^{\circ}\text{C}$ (verified by measurement results).

CERTIFICATE

Certified Passive House Component

Component-ID 0975vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.
Netherlands**
Product name: **ComfoAir Q600 HRV, Comfort Vent Q600
HRV**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
70–460 m ³ /h
Heat recovery rate
$\eta_{HR} = 87\%$
Specific electric power
$P_{el,spec} = 0.24 \text{ Wh/m}^3$

- At an airflow of 223 m³/h, a heat recovery of $\eta_{HR} = 91\%$ is reached.
- Due to the frost protection strategy at outdoor temperatures of -15°C the air flow rate is reduced to about 280 m³/h.

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in W h/(kg K)

Heat recovery rate

$$\eta_{HR} = 87\%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.24 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.70$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
0.38 %	0.19 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 70–460 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 1.30 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 460 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
50.9 dB(A)	47.4 dB(A)	65.3 dB(A)	47.1 dB(A)	66.7 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures ($-15\text{ }^{\circ}\text{C}$). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

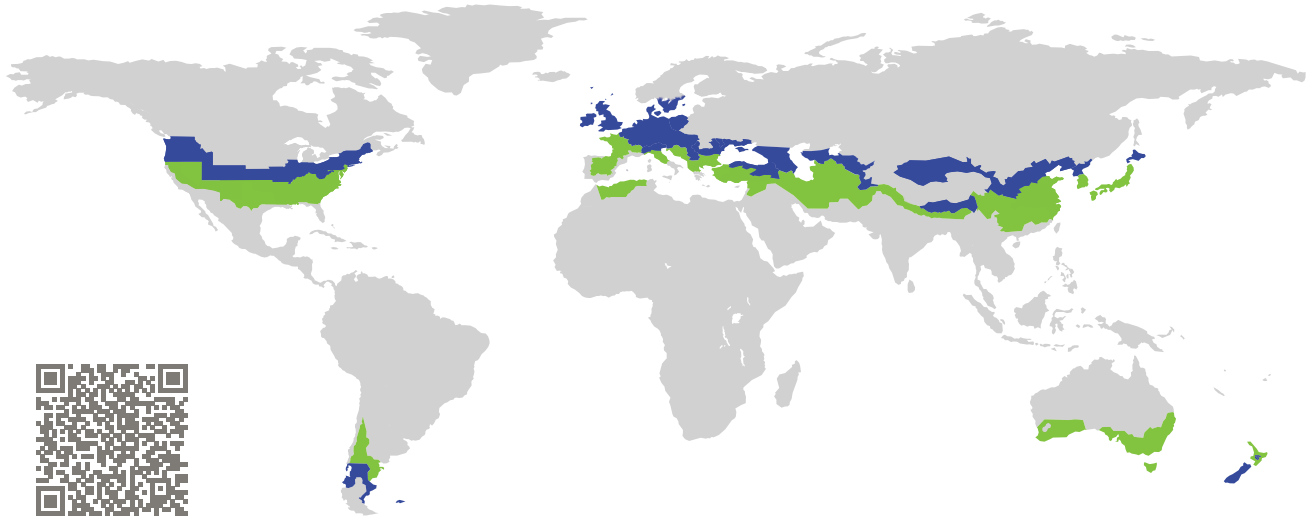
- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing, the unit can optionally be equipped with an electrical preheater of 2.4 kW. The pre heating power is controlled depending on the outdoor air- and supply air temperature. In the measurement the preheater was activated at an outdoor air temperature of $-9.1\text{ }^{\circ}\text{C}$. Due to the frost protection strategy, the air flow rate will be reduced to about $280\text{ m}^3/\text{h}$ at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$. In order to ensure the upper air flow rate of $460\text{ m}^3/\text{h}$ even at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$, an additional preheater power or a post-heater is recommended.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic heater coil the device is switched off as soon as the supply air temperature falls below about $2.9\text{ }^{\circ}\text{C}$ (verified by measurement results).

CERTIFICATE

Certified Passive House Component

Component-ID 0954vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir Q450 HRV, Comfort Vent Q450 HRV**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$
Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
at outdoor air temperature -10°C

Airflow range
70–345 m ³ /h
Heat recovery rate
$\eta_{HR} = 88\%$
Specific electric power
$P_{el,spec} = 0.21 \text{ Wh/m}^3$

- At an airflow of 89 m³/h, a heat recovery of $\eta_{HR} = 94\%$ is reached.
- Due to the frost protection strategy at outdoor temperatures of -15°C the air flow rate is reduced to about 255 m³/h.

cool, temperate climate



CERTIFIED COMPONENT

Passive House Institute

Passive House comfort criterion

A minimum supply air temperature of 16.5 °C is maintained at an outdoor air temperature of -10 °C.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

- η_{HR} Heat recovery rate in %
- θ_{ETA} Extract air temperature in °C
- θ_{EHA} Exhaust air temperature in °C
- θ_{ODA} Outdoor air temperature in °C
- P_{el} Electric power in W
- \dot{m} Mass flow in kg/h
- c_p Specific heat capacity in Wh/(kg K)

Heat recovery rate

$$\eta_{HR} = 88\%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.21 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.73$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage	External leakage
0.26 %	0.23 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 70–345 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 1.30 W and therefore not complies with the target value of 1 W. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 347 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
47.0 dB(A)	44.3 dB(A)	58.7 dB(A)	46.4 dB(A)	60.0 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is equipped with following filter qualities by default:

Outdoor air filter	Extract air filter
G4	G4

On the outdoor air/ supply air side the filter quality class F7 is recommended. If not standard configuration, the F7 filter is available as accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures ($-15\text{ }^{\circ}\text{C}$). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing, the unit can optionally be equipped with an electrical preheater of 2.2 kW. The pre heating power is controlled depending on the outdoor air- and supply air temperature. In the measurement the preheater was activated at an outdoor air temperature of $-8.8\text{ }^{\circ}\text{C}$. Due to the frost protection strategy, the air flow rate will be reduced to about $255\text{ m}^3/\text{h}$ at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$. In order to ensure the upper air flow rate of $345\text{ m}^3/\text{h}$ even at an outdoor air temperature of $-15\text{ }^{\circ}\text{C}$, an additional preheater power or a post-heater is recommended.
- Frost protection of downstream hydraulic heater coils:
 - ✓ In order to protect a downstream hydraulic heater coil the device is switched off as soon as the supply air temperature falls below $10.8\text{ }^{\circ}\text{C}$ (verified by measurement results).