Tetris W Rev FC/NG

40÷640 kW

General
Free-cooling chillers for indoor installations.
Extended range, versatile applications.
No Glycol.

Configurations
HE: Version with oversize free-cooling heat exchanger

/LN: silenced unit

Strengths

- 2 free-cooling configurations available
- Tier 2 compliance: sizes up to 400 kW
- No glycol on user side
- Hybrid free-cooling: mixed free-cooling/chiller mode in spring and autumn
- Integrated management of chiller, free-cooling and external dry-cooler
- Easy handling: depth ≤ 880 mm
- BlueThink advanced control with integrated web server. Multilogic function and Blueye® supervision system. (options)
- Flowzer: inverter driven pumps (options)

BlueBox by Swegon

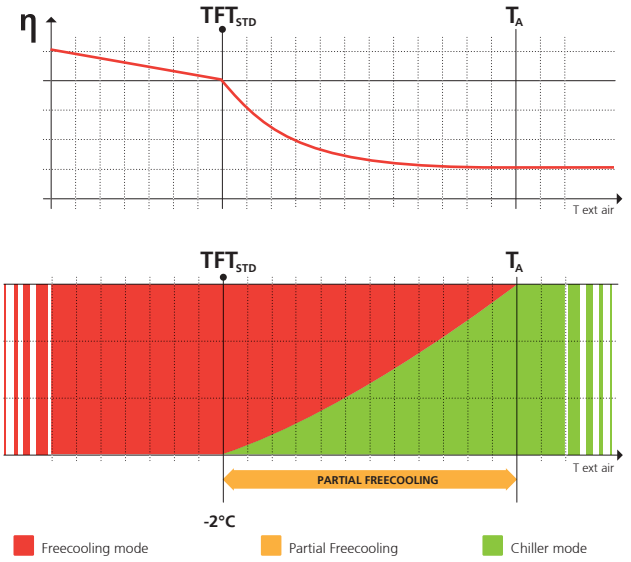
THE PACKAGED FREE COOLING SYSTEM

Free cooling is carried out when the outside air temperature is lower than the temperature of the water returning from the system. In these conditions, a suitably configured system allows chilled water to be obtained without the need for operation of the compressors and therefore almost cost free.

A cooling system that allows free cooling conditions to be exploited is made by placing an air liquid cooler (normally a dry-cooler) alongside a conventional chiller. The apparent simplicity of a system formed in this way hides a non-negligible pitfall: management.

In fact, a system of this kind is normally controlled by a "manager" outside the chiller that, in order to limit the degree of complexity, usually manages everything with an ON/OFF free-cooling logic, that is, either only chiller or only free cooling.

Actually, there are numerous situations in which free cooling can be used even when the conditions for obtaining the total cooling capacity required by the system are not present; it can make an important contribution to reducing the total consumption of the chiller section that will only have to add the missing amount of capacity.



An outside air temperature TA can be defined, below which the free-cooling section is activated even though it can provide only a small portion of the required cooling capacity. From this moment on, it is necessary to introduce the concept of machine efficiency η, which no longer coincides with the known EER because the cooling capacity that the unit can deliver no longer totally depends on the power consumed by the compressors as it also benefits from the component coming from free cooling.

In the same way, we define the Total Free-cooling Temperature (TFT) as the outside air temperature at which the capacity that can be obtained from free cooling is the same as that delivered by the refrigerant circuit under nominal conditions.

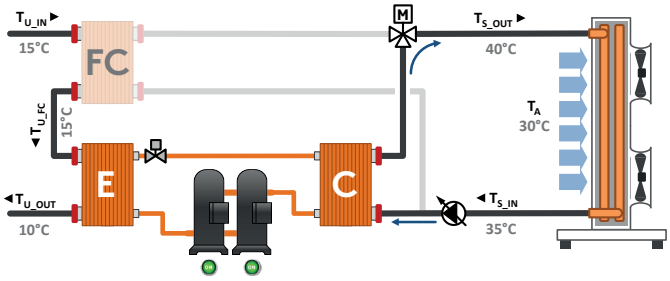
When the TFT is reached, the efficiency value η is extremely high because the power consumed by the system in this condition is the power consumed by just the pumps and the fans. So therefore the efficiency of the unit can easily reach values even higher than 15.

In its standard configuration, **Tetris W Rev FC/NG** includes an inverter-controlled source-side pump, a 3-way modulating valve installed in the machine for management of the water flow rate to the free cooling heat exchanger and management of the external dry-cooler. This level of integration allows the control of the unit to have full management of the system and therefore gives it the ability to work in "partial free cooling" mode, thereby obtaining very high efficiency levels.

If we consider the case of a typical industrial installation in which chilled water production at a temperature of 10°C at the user side is required, then the TA will be a few degrees lower. It follows that, in situations of this kind, even for latitudes corresponding to those of Frankfurt, the partial free cooling mode is used for over half of the yearly hours of operation with enormous benefits in terms of reduction of the total energy consumed over the year. In particular, the saving will be highest for applications that envisage continuous operation without seasonal stops.

Depending on the outside air temperature, the unit can work in three different operating modes.

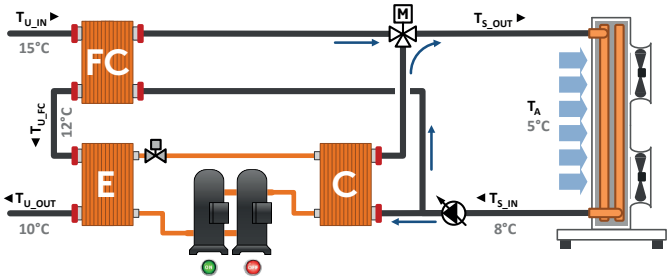
Pure chiller mode



The free cooling heat exchanger is completely excluded by the 3-way valve, and the cooling capacity is provided entirely by the refrigerant circuit through operation of the compressors.

The external dry-cooler should be sized to discharge the capacity to be condensed in these conditions, and therefore on a par with a system having a unit that does not allow free cooling.

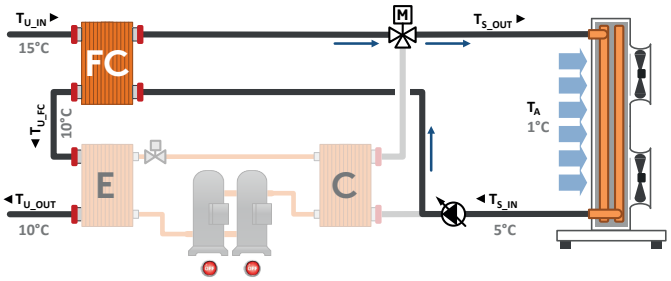
Mixed mode



The outside air temperature is not low enough to allow all the capacity required by the system to be obtained through free cooling, but is in any case able to guarantee coverage of a part of it. The 3-way valve modulates the opening so as to have source fluid passing through the free cooling heat exchanger and also through the condenser.

This condition, called "partial free cooling", occurs much more often than the total free cooling condition and guarantees an energy saving compared to the pure chiller mode because a capacity reduction of the compressors will be obtained with consequent energy saving.

Pure free cooling mode



When the outside air temperature is low enough (that is, less than or equal to the TFT), all the capacity needed to cover the immediate requirements of the system is totally produced by making use of free cooling and keeping the compressors of the chiller section switched off.

Two efficiency levels to choose from

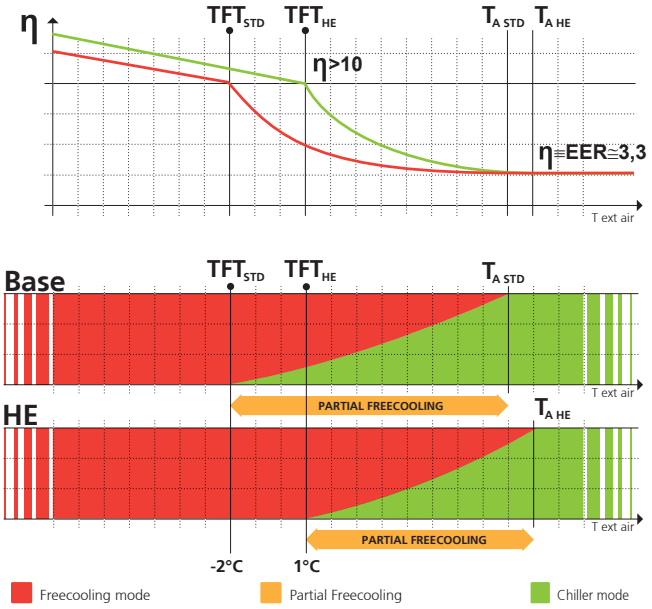
It is clear how, for the same external dry cooler performance, the TFT (Total Freecooling Temperature) depends on the sizing of the plate heat exchanger dedicated to free cooling inside the unit. By using a more generous sizing of this heat exchanger, it is therefore possible to raise the value of the TFT and so increase the total number of hours per year during which the unit works in partial and total free cooling conditions.

By working on the size of the heat exchange parts, we have chosen to make two set-ups available on the entire range. These in turn lead to obtaining two TFT values:

- Basic: allows the TFT at -2°C
- HE: allows the TFT at 1°C

These temperature levels refer to the unit working under nominal conditions (E.G.30% 35/40°C; W 15/10°C) combined with an ideal dry-cooler that, at an outside air temperature of 30°C, is able to exactly discharge the capacity to be condensed.

The following diagram shows a comparison of the efficiency and of the capacity obtained by free cooling for the two different set-ups.

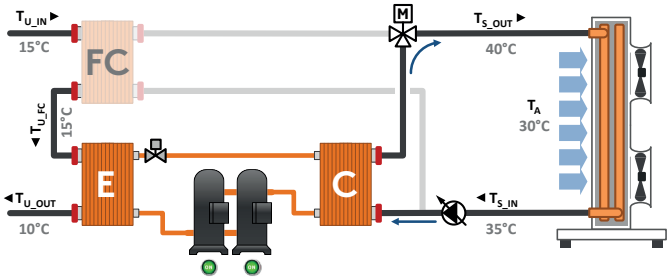


OPERATING MODE

The outside air temperature is an essential parameter for establishing which operating mode of the unit, not just in terms of whether or not free cooling is activated, but also in terms of the condensation control procedure and of the capacity generated by the machine.

Five operating scenarios, which are made for various outside air temperatures TA, are described in detail below.

Scenario 1

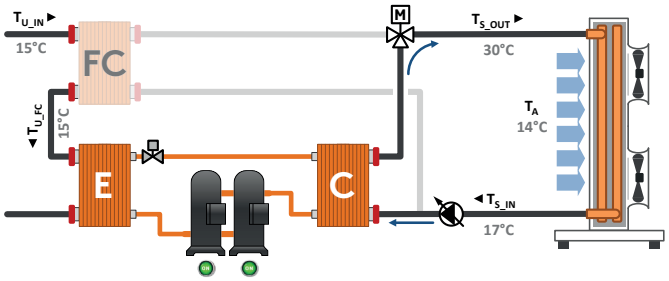


Chiller mode

Conditions surrounding the system: TA > TU_IN

- Freecooling: **OFF**
- Compressors: **ON**
- Source-side pump: **100%**
- 3-way valve: fully closed
- Dry-cooler: speed of the fans set to carry out the condensation control of the chiller (high set point)

Scenario 2

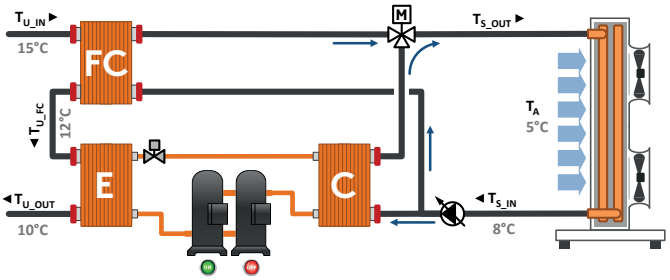


Chiller mode

Conditions surrounding the system: TA < TU_IN, TS_IN > TU_IN

- Freecooling: **OFF**
- Compressors: **ON**
- Source-side pump: works in modulating mode to control condensation
- 3-way valve: fully closed
- Dry-cooler: speed of the fans set to obtain the maximum performance (low set point)

Scenario 3

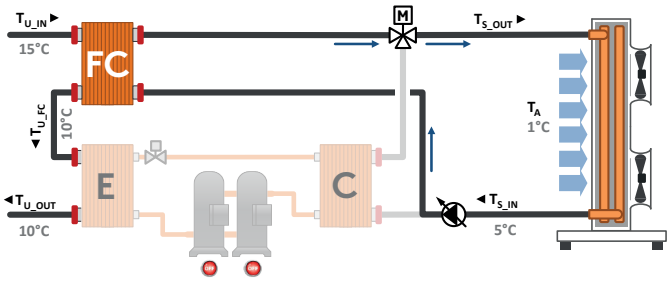


Partial free cooling mode

Conditions surrounding the system: (TS_IN + δ) < TU_IN

- Freecooling: **ON**
- Compressors: **ON (at reduced capacity)**
- Source-side pump: **100%**
- 3-way valve: partially open. Modules to guarantee condensation control and feeding of the free cooling heat exchanger
- Dry-cooler: speed of the fans set to obtain the maximum performance (low set point)

Scenario 4

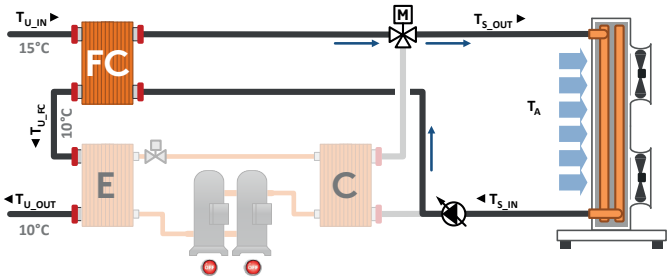


Free cooling mode (TFT)

Conditions surrounding the system: TU_FC = 10°C = TU_OUT

- Freecooling: **ON**
- Compressors: **OFF**
- Source-side pump: **100%**
- 3-way valve: fully open
- Dry-cooler: speed of the fans set to control TS_IN and therefore the output capacity at the free cooling heat exchanger

Scenario 5



Free cooling mode

Conditions surrounding the system: TA << 0°C

- Freecooling: **ON**
- Compressors: **OFF**
- Source-side pump: modulates its speed to guarantee control of cooling capacity at the free cooling heat exchanger
- 3-way valve: fully open
- Dry-cooler: **OFF**

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REFRIGERANT

The unit is charged with refrigerant R410A, with GWP=2088 (value at 100 years).

BODY

The structure consists of a load-bearing frame made of epoxy polyester powder coated steel sheet, coloured with RAL 7035.

All screws and bolts are stainless steel.

Models from 3.2 to 34.4 and models 37.4, 38.4, 39.4, 40.4, 47.4, 48.4, 53.4, 54.4, 55.6, 56.6 and 59.6 are all made in a monoblock structure that houses all the components of the chiller section, free cooling section and hydraulic section.

Otherwise, to guarantee easier handling on site, for models 38.4, 40.4, 48.4, 54.4, 56.6 and 60.6, the structure is divided into two parts: one module consists of the chiller (compressors and refrigerant circuit) while the other module is made to contain the free cooling section and the hydraulic circuit with the pumps.

The two modules can be placed in any reciprocal position considering that, once they are positioned on site, they will have to be hydraulically and electrically connected (by the customer).

COMPRESSORS

The compressors are hermetic orbiting spiral scroll compressors connected in tandem or trio, fitted with oil level sight glass, oil equalization line and electronic protection.

USER-SIDE HEAT EXCHANGER

The exchanger is a braze-welded stainless steel plate heat exchanger, insulated with a shroud of closed-cell insulating material. Models with 2 refrigerant circuits are fitted with dual circuit heat exchanger.

The use of plate heat exchangers allows us to:

- maximize the EER and COP levels
- reduce the amount of refrigerant used in the unit
- make the unit lighter and more compact
- make its maintenance easier.

The heat exchanger is provided with a temperature probe for freeze protection and a differential pressure switch.

SOURCE-SIDE HEAT EXCHANGER

The exchanger is a braze-welded stainless steel plate heat exchanger, insulated with a shroud of closed-cell insulating material. Models with 2 refrigerant circuits are fitted with dual circuit heat exchanger.

FREE-COOLING CIRCUIT

The free cooling circuit consists of:

- a water-water heat exchanger: this is a brazed AISI stainless steel plate heat exchanger with anti-condensation insulation made of closed-cell insulating material. The heat exchanger makes the separation between the source side (glycol) and the user side (non-glycol) and allows transfer of cooling capacity from one side to the other during operation in free cooling mode.
- a 3-way modulating valve: the valve, complete with servo control, allows the free cooling circuit to be fed and the condensation control to be carried out when the unit is working in mixed chiller-free cooling mode.
- an inverter-controlled source-side pump: all the units are completed as standard with an inverter-controlled source-side pump (1SV). The inverter allows the water flow rate to be modulated on the source side in order to carry out condensation control or control of output capacity at the free cooling heat exchanger.

For models 38.4, 40.4, 48.4, 54.4, 56.6 and 60.6, all these components are gathered in a separate section from the chiller section so as to make on-site handling operations easier. The two sections are to be hydraulically and electrically connected on site (by the customer).

REFRIGERANT CIRCUIT

Each refrigerant circuit of the basic unit (cooling only) comprises:

- shut-off valve in the liquid line
- 5/16” charging valves
- liquid sight glass
- replaceable solid cartridge dehydrator filter
- electronic expansion valve
- pressure transducers for reading the high and low pressure values and relevant evaporating and condensing temperatures
- high pressure switches

The pipes of the circuit and the exchanger are insulated with extruded closed-cell expanded elastomer.

Compared to the mechanical expansion valve, the electronic expansion valve allows machine stability to be reached more quickly and better superheating control to maximize the use of the evaporator in all load conditions. This also acts as shut-off valve on the liquid line, as it closes during compressor stops, so preventing dangerous refrigerant migration.

ELECTRICAL CONTROL PANEL

The electrical control panel is made in a painted galvanized sheet-iron box.

The electrical control panel of the basic unit comprises:

- main disconnect switch
- automatic circuit breakers for compressors with fixed calibration
- fuses to protect the auxiliary circuits
- thermal magnetic circuit breakers for the pumps (if present)
- contactors for compressors and pumps (if present)
- phase monitor
- potential-free general alarm contacts
- single potential free operating contacts for compressors and pumps (if present)
- microprocessor controller with display accessible from the outside

All the electrical cables inside the panel are numbered and the terminal board dedicated to the customer's connections is coloured orange so that it can be quickly identified in the panel.

The power supply of the unit is 400V/3~/50Hz.

For models 38.4, 40.4, 48.4, 54.4, 56.6 and 60.6, the free cooling module is separate from the chiller module and is equipped with a secondary electrical control panel having a main disconnect switch and into which are transferred components for management of the pumps, remote air heat exchanger (dry-cooler) and 3-way valve. The power supply to the secondary electrical control panel is taken from the main electrical control panel.

CONTROL BLUETHINK

Main controller functions advanced

The control allows the following functions:

- water temperature adjustment, with control of the water entering the user-side heat exchanger
- freeze protection
- compressor timings
- automatic rotation of compressor starting sequence
- recording of the log of all machine inputs, outputs and states
- automatic rotation of compressor starting sequence
- recording of the alarm log
- RS485 serial port with Modbus protocol
- Ethernet serial port with Modbus protocol and integrated web server preloaded web page
- digital input for general ON/OFF

For further details on available functions and on displayed information, you can refer to the specific documentation of the control.

By default, the serial connections present as standard are enabled only for reading from BMS. Enabling of writing from BMS is to be requested when ordering.

Main functions of the webserver (only for units with advanced control)

As standard, the Bluethink controller integrates a webserver with a preloaded web page that is accessed via password.

The web page allows the following functions to be carried out (some of these are available only for users with advanced level rights):

- display of the main functions of the unit such as unit serial n°, size, refrigerant
- display of the general status of the machine: water inlet and outlet temperatures, external air temperature, mode (chiller or heat pump), evaporating and condensing pressures, suction and discharge temperatures
- display of the status of compressors, pumps, expansion valves
- display in real time of the graphs of the main quantities
- display of the graphs of logged quantities
- display of alarm log
- management of users on several levels
- remote ON/OFF
- remote set point change
- remote time band change

Human-Machine Interface

The control has a graphic display that allows the following information to be displayed:

- water inlet and outlet temperature
- set temperature and differential set points
- description of alarms
- hour meter of operation and number of start-ups of the unit, the compressors and the pumps (if present)
- high and low pressure values, and relevant condensing and evaporating temperatures
- external air temperature
- superheating at compressor suction.

CONTROLS AND SAFETY DEVICES

All the units are fitted with the following control and safety components:

- high pressure switch with manual reset
- high pressure safety device with automatic reset, for a limited number of occurrences, managed by the controller
- low pressure safety device with automatic reset and limited tripping managed by the controller
- high pressure safety valve
- antifreeze probe at outlet of each evaporator
- compressor overtemperature protection
- mechanical paddle flow switch (supplied loose)

TESTING

All the units are factory-tested and supplied complete with oil and refrigerant.

PACKAGING

The unit is made and shipped on a wooden pallet that allows the unit to be handled using a forklift truck.

The unit is wrapped in transparent polyethylene stretch film.

VERSIONS

In the basic version, the unit has a high efficiency chiller section and includes a free cooling heat exchanger that, under nominal conditions and with a suitably sized remote air heat exchanger, allows a TFT (Total Freecooling Temperature) of about -2°C.

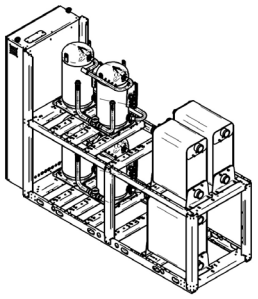
HE: high efficiency free cooling section

The HE unit includes an oversize free cooling heat exchanger that allows a rise in the TFT to about +1°C.

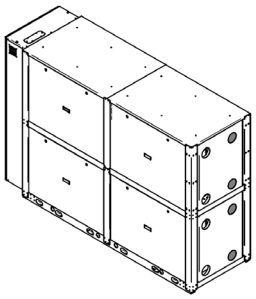
OPTIONS

/LN: silenced unit

Units in LN set-up are fully panelled with epoxy polyester powder coated steel sheet panels coloured with RAL 7035 and lined with matting made of sound absorbing and soundproofing material.



Example of non /LN unit



Example of /LN unit

HYDRAULIC MODULES

All the units can be equipped with hydraulic module in various combinations on the user side and on the source side. Refer to the table of configurations that are not possible to check for availability of specific set-ups.

Hydraulic modules with one pump have:

- one pump
- a gate valve on the delivery side of the pump
- an expansion vessel

Hydraulic modules with two pumps have:

- two pumps
- a check valve on the delivery side of each pump
- a gate valve on the outlet of the delivery manifold
- an expansion vessel

In the version with 2 pumps, these are always with one on standby while the other is working. Switching over between the pumps is automatic and is done by time (to balance the hours of operation of each one) or in the event of failure.

User-side hydraulic modules

The hydraulic circuit inside the unit is fully insulated with closed-cell insulating material..

The module can have the following configurations:

- /1P: hydraulic module with one pump
- /2P: hydraulic module with two pumps

All the above-mentioned modules have pumps with standard discharge head.

The following are also available:

modules /1PM and /2PM that have pumps with increased available discharge head

Source-side hydraulic modules

The source-side pumps are always inverter-controlled to modulate the water flow rate to the source side and free cooling heat exchangers. Modulation of the inverter is done directly by the control depending on the condensing temperature and the free cooling heat exchanger outlet temperature (user side).

As standard supply, all the units are in /1SV set-up that includes one inverter-controlled pump.

The module can have the following configurations:

- /2SV: hydraulic module with two inverter-controlled pumps

All the above-mentioned modules have pumps with standard discharge head.

The following are also available:

modules /1SVM and /2SVM that have pumps with increased available discharge head

modules /1SVG and /2SVG that have pumps suitable for operating with glycol up to 50%

TECHNICAL SPECIFICATIONS

TETRIS W REV FC/NG

			3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2
Cooling (EG30% 35/40; W15/10)										
Refrigeration capacity	(1)	kW	39,5	45,0	51,5	57,0	65,8	74,0	84,7	102,9
Total absorbed power	(1)	kW	9,4	11,0	12,3	13,6	15,8	17,4	19,7	24,0
EER	(1)		4,18	4,10	4,18	4,19	4,16	4,26	4,29	4,28
Free-Cooling										
TFT of basic version	(3)	°C	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00
TFT of /HE version	(3)	°C	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Compressors										
Compressors/Circuits		n°/n°	2/1	2/1	2/1	2/1	2/1	2/1	2/1	2/1
Minimum capacity reduction step	(8)	%	50%	50%	50%	50%	50%	50%	50%	50%
Refrigerant charge		kg	3,8	4	4,5	7,5	7,7	7,8	8	8,5
User-side heat exchangers										
Water flow rate	(1)	m³/h	6,9	7,8	9,0	9,9	11,5	12,9	14,7	17,9
Total head losses	(1)	kPa	80	95	96	109	112	104	113	127
Total water content		l	10	10	12	13	17	21	24	25
Evaporator										
Quantity		n°	1	1	1	1	1	1	1	1
Basic version of free cooling heat exchanger										
Water content	(6)	l	4	4	5	5	8	9	12	14
Head loss	(1)	kPa	43	57	44	58	49	62	59	73
HE version of free cooling heat exchanger										
Water content	(6)	l	7	7	9	9	12	15	17	17
Head loss	(1)	kPa	43	57	44	58	56	59	65	88
Source-side heat exchanger										
Flow rate of water and 30% glycol	(1)	m³/h	9,4	10,7	12,3	13,6	15,7	17,6	20,1	24,4
Total head losses	(1)	kPa	88	111	112	122	128	85	97	108
Quantity		n°	1	1	1	1	1	1	1	1
Water content		l	3	3	4	4	5	7	8	9
Noise levels										
Sound power level of basic unit	(4)	dB(A)	73	75	75	77	77	78	79	80
Sound pressure level of basic unit	(5)	dB(A)	57	59	60	62	62	63	63	65
Sound power level of LN version	(4)	dB(A)	66	68	68	70	70	71	72	73
Sound pressure level of LN version	(5)	dB(A)	50	52	53	55	55	56	56	58
Dimensions and weights**										
Length		mm	1.633	1.633	1.633	1.633	1.633	1.633	1.633	1.633
Depth		mm	800	800	800	800	800	800	800	800
Height		mm	1.880	1.880	1.880	1.880	1.880	1.880	1.880	1.880
Operating weight		kg	330	340	380	400	400	440	460	470

(1) E.G. source fluid 30%; water temperature inlet-outlet source exchanger 35/40 ° C; water temperature inlet-outlet user exchanger 15/10 ° C. Values according to EN 14511 standard

(3) The indicated TFT is calculated considering the coupling with a drycooler sized to allow the unit to operate under nominal conditions with 30 ° C of outside air

(4) Unit operating at rated speed, without any accessory, with water temperature inlet-outlet source exchanger 35-40 ° C and water temperature inlet-outlet user exchanger 15-10 ° C.

(5) Values obtained from the sound power level (conditions: note 4), related to a distance of 1 m from the unit in free field with directivity factor Q=2. Non-binding values.

(6) This volume considers both the water content of the exchanger and an estimate of the volume of water contained in the pipes of the freecooling section

(8) Approximate value. The minimum capacity reached by the unit depends on the operating conditions. The value shown may not be suitable for calculating the minimum volume of water: to do this, consult the “Minimum water content in the system” section.

** Chiller version without accessories (chiller section + freecooling)

TETRIS W REV FC/NG

			12.2	13.2	15.2	17.2	19.2	20.2	24.2	27.2
Cooling (EG30% 35/40; W15/10)										
Refrigeration capacity	(1)	kW	116,9	134,7	149,6	165,6	188,3	205,8	228,9	258,3
Total absorbed power	(1)	kW	26,9	31,1	34,4	38,2	44,1	49,3	54,1	61,3
EER	(1)		4,34	4,33	4,35	4,33	4,26	4,17	4,23	4,21
Free-Cooling										
TFT of basic version	(3)	°C	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00
TFT of /HE version	(3)	°C	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Compressors										
Compressors/Circuits		n°/n°	2/1	2/1	2/1	2/1	2/1	2/1	2/1	2/1
Minimum capacity reduction step	(8)	%	43%	50%	44%	50%	45%	50%	50%	50%
Refrigerant charge		kg	10	11,5	12	14	15	15	21	21
User-side heat exchangers										
Water flow rate	(1)	m³/h	20,3	23,4	26,0	28,7	32,7	35,8	39,7	44,9
Total head losses	(1)	kPa	107	116	114	103	114	135	119	141
Total water content		l	31	33	36	48	49	50	92	96
Evaporator										
Quantity		n°	1	1	1	1	1	1	1	1
Basic version of free cooling heat exchanger										
Water content	(6)	l	12	12	16	16	20	20	26	29
Head loss	(1)	kPa	42	52	44	54	40	50	38	48
HE version of free cooling heat exchanger										
Water content	(6)	l	22	22	24	34	34	34	42	45
Head loss	(1)	kPa	36	46	57	33	44	55	47	59
Source-side heat exchanger										
Flow rate of water and 30% glycol	(1)	m³/h	27,8	32,0	35,5	39,3	44,7	49,1	54,6	61,6
Total head losses	(1)	kPa	92	100	111	120	147	142	110	130
Quantity		n°	1	1	1	1	1	1	1	1
Water content		l	10	12	13	15	16	18	30	32
Noise levels										
Sound power level of basic unit	(4)	dB(A)	83	84	85	85	86	87	87	88
Sound pressure level of basic unit	(5)	dB(A)	66	67	69	69	70	71	71	71
Sound power level of LN version	(4)	dB(A)	76	77	78	78	79	80	80	81
Sound pressure level of LN version	(5)	dB(A)	59	60	62	62	63	64	64	64
Dimensions and weights**										
Length		mm	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
Depth		mm	800	800	800	800	800	800	800	800
Height		mm	1.880	1.880	1.880	1.880	1.880	1.880	1.880	1.880
Operating weight		kg	580	670	700	740	770	800	860	880

(1) E.G. source fluid 30%; water temperature inlet-outlet source exchanger 35/40 ° C; water temperature inlet-outlet user exchanger 15/10 ° C. Values according to EN 14511 standard

(3) The indicated TFT is calculated considering the coupling with a drycooler sized to allow the unit to operate under nominal conditions with 30 ° C of outside air

(4) Unit operating at rated speed, without any accessory, with water temperature inlet-outlet source exchanger 35-40 ° C and water temperature inlet-outlet user exchanger 15-10 ° C.

(5) Values obtained from the sound power level (conditions: note 4), related to a distance of 1 m from the unit in free field with directivity factor Q=2. Non-binding values.

(6) This volume considers both the water content of the exchanger and an estimate of the volume of water contained in the pipes of the freecooling section

(8) Approximate value. The minimum capacity reached by the unit depends on the operating conditions. The value shown may not be suitable for calculating the minimum volume of water: to do this, consult the “Minimum water content in the system” section.

** Chiller version without accessories (chiller section + freecooling)

TETRIS W REV FC/NG

			30.3	34.3	40.3	18.4	20.4	24.4	26.4	30.4	34.4
Cooling (EG30% 35/40; W15/10)											
Refrigeration capacity	(1)	kW	328,0	370,2	413,9	168,8	204,4	232,9	262,6	297,5	331,0
Total absorbed power	(1)	kW	75,9	85,2	95,4	39,0	47,2	54,0	60,7	68,5	77,3
EER	(1)		4,32	4,34	4,34	4,33	4,33	4,31	4,32	4,34	4,28
Free-Cooling											
TFT of basic version	(3)	°C	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00
TFT of /HE version	(3)	°C	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Compressors											
Compressors/Circuits		n°/n°	3/1	3/1	3/1	4/2	4/2	4/2	4/2	4/2	4/2
Minimum capacity reduction step	(8)	%	33%	33%	33%	25%	25%	21%	25%	22%	25%
Refrigerant charge		kg	27	31	33	18	18	20,5	25	27	29
User-side heat exchangers											
Water flow rate	(1)	m³/h	56,9	64,3	71,9	29,2	35,4	40,4	45,6	51,6	57,4
Total head losses	(1)	kPa	125	145	142	82	97	113	117	112	123
Total water content		l	117	118	133	52	57	67	66	69	76
Evaporator											
Quantity		n°	1	1	1	1	1	1	1	1	1
Basic version of free cooling heat exchanger											
Water content	(6)	l	39	49	63	14	19	19	23	23	29
Head loss	(1)	kPa	47	50	47	34	47	59	46	41	49
HE version of free cooling heat exchanger											
Water content	(6)	l	65	65	79	24	27	37	37	37	45
Head loss	(1)	kPa	52	63	44	38	51	46	57	44	55
Source-side heat exchanger											
Flow rate of water and 30% glycol	(1)	m³/h	77,8	87,8	98,0	40,0	48,5	55,3	62,3	70,6	78,6
Total head losses	(1)	kPa	150	133	158	117	103	124	119	123	144
Quantity		n°	1	1	1	1	1	1	1	1	1
Water content		l	35	44	51	15	17	19	22	24	28
Noise levels											
Sound power level of basic unit	(4)	dB(A)	88	88	90	82	83	86	87	88	88
Sound pressure level of basic unit	(5)	dB(A)	71	71	73	65	66	69	69	71	71
Sound power level of LN version	(4)	dB(A)	81	81	83	75	76	79	80	81	81
Sound pressure level of LN version	(5)	dB(A)	64	64	66	58	59	62	62	64	64
Dimensions and weights**											
Length		mm	4.505	4.505	4.505	3.685	3.685	4.502	4.502	4.502	4.502
Depth		mm	880	880	880	880	880	880	880	880	880
Height		mm	1.880	1.880	1.880	1.880	1.880	1.880	1.880	1.880	1.880
Operating weight		kg	1220	1260	1340	770	800	1030	1210	1270	1350

(1) E.G. source fluid 30%; water temperature inlet-outlet source exchanger 35/40 ° C; water temperature inlet-outlet user exchanger 15/10 ° C. Values according to EN 14511 standard

(3) The indicated TFT is calculated considering the coupling with a drycooler sized to allow the unit to operate under nominal conditions with 30 ° C of outside air

(4) Unit operating at rated speed, without any accessory, with water temperature inlet-outlet source exchanger 35-40 ° C and water temperature inlet-outlet user exchanger 15-10 ° C.

(5) Values obtained from the sound power level (conditions: note 4), related to a distance of 1 m from the unit in free field with directivity factor Q=2. Non-binding values.

(6) This volume considers both the water content of the exchanger and an estimate of the volume of water contained in the pipes of the freecooling section

(8) Approximate value. The minimum capacity reached by the unit depends on the operating conditions. The value shown may not be suitable for calculating the minimum volume of water: to do this, consult the "Minimum water content in the system" section.

** Chiller version without accessories (chiller section + freecooling)

TETRIS W REV FC/NG

			37.4	39.4	47.4	53.4	55.6	59.6
Cooling (EG30% 35/40; W15/10)								
Refrigeration capacity	(1)	kW	377,3	423,1	467,6	526,7	563,1	633,9
Total absorbed power	(1)	kW	87,9	99,9	109,7	122,8	130,2	147,6
EER	(1)		4,29	4,23	4,26	4,29	4,33	4,30
Free-Cooling								
TFT of basic version	(3)	°C	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00
TFT of /HE version	(3)	°C	1,00	1,00	1,00	1,00	1,00	1,00
Compressors								
Compressors/Circuits		n°/n°	4/2	4/2	4/2	4/2	6/2	6/2
Minimum capacity reduction step	(8)	%	23%	25%	25%	25%	15%	17%
Refrigerant charge		kg	42	43	44	45	55,5	56
User-side heat exchangers								
Water flow rate	(1)	m³/h	65,4	73,4	81,0	91,3	97,5	109,9
Total head losses	(1)	kPa	96	131	102	118	100	118
Total water content		l	123	139	121	147	180	183
Evaporator								
Quantity		n°	1	1	1	1	1	1
Basic version of free cooling heat exchanger								
Water content	(6)	l	63	63	76	76	88	88
Head loss	(1)	kPa	42	53	41	51	42	53
HE version of free cooling heat exchanger								
Water content	(6)	l	79	93	93	118	118	118
Head loss	(1)	kPa	40	35	43	34	34	34
Source-side heat exchanger								
Flow rate of water and 30% glycol	(1)	m³/h	89,6	100,6	111,4	125,2	133,6	150,5
Total head losses	(1)	kPa	151	172	108	128	140	154
Quantity		n°	1	1	1	1	1	1
Water content		l	46	50	50	57	59	65
Noise levels								
Sound power level of basic unit	(4)	dB(A)	89	90	90	91	91	91
Sound pressure level of basic unit	(5)	dB(A)	72	72	73	73	73	73
Sound power level of LN version	(4)	dB(A)	82	83	83	84	84	84
Sound pressure level of LN version	(5)	dB(A)	65	65	66	66	66	66
Dimensions and weights**								
Length		mm	4.502	4.502	4.502	4.502	5.002	5.002
Depth		mm	872	872	872	872	872	872
Height		mm	1.880	1.880	1.880	1.880	1.880	1.880
Operating weight		kg	1500	1580	1630	1710	2030	2150

(1) E.G. source fluid 30%; water temperature inlet-outlet source exchanger 35/40 ° C; water temperature inlet-outlet user exchanger 15/10 ° C. Values according to EN 14511 standard

(3) The indicated TFT is calculated considering the coupling with a drycooler sized to allow the unit to operate under nominal conditions with 30 ° C of outside air

(4) Unit operating at rated speed, without any accessory, with water temperature inlet-outlet source exchanger 35-40 ° C and water temperature inlet-outlet user exchanger 15-10 ° C.

(5) Values obtained from the sound power level (conditions: note 4), related to a distance of 1 m from the unit in free field with directivity factor Q=2. Non-binding values.

(6) This volume considers both the water content of the exchanger and an estimate of the volume of water contained in the pipes of the freecooling section

(8) Approximate value. The minimum capacity reached by the unit depends on the operating conditions. The value shown may not be suitable for calculating the minimum volume of water: to do this, consult the "Minimum water content in the system" section.

** Chiller version without accessories (chiller section + freecooling)

TETRIS W REV FC/NG

			38.4	40.4	48.4	54.4	56.6	60.6
Cooling (EG30% 35/40; W15/10)								
Refrigeration capacity	(1)	kW	377,3	423,1	467,6	526,7	563,0	633,9
Total absorbed power	(1)	kW	87,9	99,9	109,7	122,7	130,2	147,6
EER	(1)		4,29	4,23	4,26	4,29	4,32	4,30
Free-Cooling								
TFT of basic version	(3)	°C	-2,00	-2,00	-2,00	-2,00	-2,00	-2,00
TFT of /HE version	(3)	°C	1,00	1,00	1,00	1,00	1,00	1,00
Compressors								
Compressors/Circuits		n°/n°	4/2	4/2	4/2	4/2	6/2	6/2
Minimum capacity reduction step	(8)	%	23%	25%	25%	25%	15%	17%
Refrigerant charge		kg	42	43	44	45	55,5	56
User-side heat exchangers								
Water flow rate	(1)	m³/h	65,4	73,4	81,0	91,3	97,5	109,9
Total head losses	(1)	kPa	96	131	102	118	100	118
Total water content		l	123	139	121	147	180	183
Evaporator								
Quantity		n°	1	1	1	1	1	1
Basic version of free cooling heat exchanger								
Water content	(6)	l	63	63	76	76	88	88
Head loss	(1)	kPa	42	53	41	51	42	53
HE version of free cooling heat exchanger								
Water content	(6)	l	79	93	93	118	118	118
Head loss	(1)	kPa	40	35	43	34	34	34
Source-side heat exchanger								
Flow rate of water and 30% glycol	(1)	m³/h	89,6	100,6	111,4	125,2	133,6	150,5
Total head losses	(1)	kPa	151	172	108	128	140	154
Quantity		n°	1	1	1	1	1	1
Water content		l	46	50	50	57	59	65
Noise levels								
Sound power level of basic unit	(4)	dB(A)	89	90	90	91	91	91
Sound pressure level of basic unit	(5)	dB(A)	72	72	73	73	73	73
Sound power level of LN version	(4)	dB(A)	82	83	83	84	84	84
Sound pressure level of LN version	(5)	dB(A)	65	65	66	66	66	66
Dimensions and weights**								
Length		mm	2820	2820	2820	2820	3320	3320
Depth		mm	880	880	880	880	880	880
Height		mm	1880	1880	1880	1880	1880	1880
Weight in section chiller function		kg	1500	1580	1630	1710	2030	2150
Freecooling module dimensions and weights								
Length		mm	2930	2930	2930	2930	2930	2930
Depth		mm	880	880	880	880	880	880
Height		mm	1880	1880	1880	1880	1880	1880
Weight in freecooling section		kg	898	1096	1056	1602	1282	1162

(1) Source fluid E.G. 30%; source-side heat exchanger inlet-outlet water temperature 35/40°C; user-side heat exchanger inlet-outlet water temperature 15/10°C. Values compliant with standard EN 14511

(3) The indicated TFT is calculated considering coupling with a drycooler sized to allow the unit to work under nominal conditions with outside air at 30°C

(4) # tab # unit operating at rated speed, without any accessory, with water temperature inlet-outlet source exchanger 35-40 ° C and water temperature inlet-outlet user exchanger 15-10 ° C. Binding values. Values obtained from measurements performed according to ISO 3744.

(5) # tab # values obtained from the sound power level (in known condition 4), referred to a distance of 1 m from the unit in free field with directivity factor Q = 2. Non-binding values.

(6) This volume considers both the water content of the heat exchanger and an estimate of the volume of water contained in the pipes of the free cooling section

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(6) This volume considers both the water content of the heat exchanger and an estimate of the volume of water contained in the pipes of the free cooling section

(8) Approximate value. The minimum capacity reached by the unit depends on the operating conditions. The value shown may not be suitable for calculating the minimum volume of water: to do this, consult the "Minimum water content in the system" section.

** Basic CH unit without included accessories

ECODESIGN

INTRODUCTION

The Ecodesign/ErP Directive (2009/125/EC) lays down new standards for more efficient energy use.

The Directive contains various regulations; as regards chiller products and heat pumps, the regulations of interest are the following:

- Regulation 2013/813, for small heat pumps (Pdesign ≤ 400 kW)
- Regulation 2016/2281, for chillers and heat pumps with Pdesign > 400 kW
- Regulation 2013/811, for heat pumps with Pdesign ≤ 70 kW.

The last-mentioned regulation (2013/811) regards the labelling (Ecolabel certification) of small heat pumps.

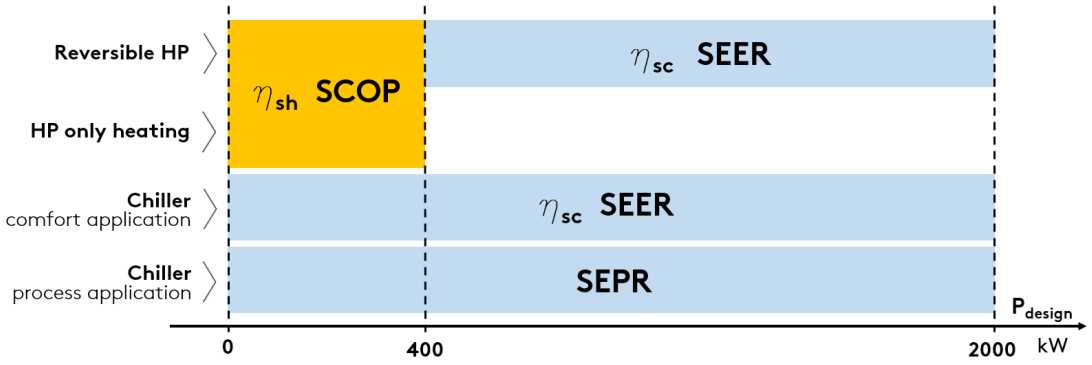
The other two regulations (2013/813 and 2016/2281) set seasonal efficiency targets that the products must comply with to be sold and installed in the European Union (essential requirement for CE marking).

These efficiency limits are defined through ratios, which are respectively:

- ηsh (SCOP), with reference to regulation 2013/813
- ηsc (SEER) for comfort applications and SEPR for process applications, with reference to regulation 2016/2281.

As regards regulation 2016/2281, with effect from 1st January 2021, the required minimum efficiency limit will be raised (Tier 2) from the current threshold (Tier 1).

The figure below schematically illustrates the correspondence between product and reference energy ratio.



Some notes and clarifications:

For comfort applications, regulation 2016/2281 sets the ηsc (SEER) ratio in two different operating conditions:

- SEER calculated with machine inlet/outlet water temperature of 12/7°C (low temperature application),
- SEER calculated with machine inlet/outlet water temperature of 23/18°C (medium temperature application).

The minimum efficiency requirement is the same, but can be met at condition 12/7°C or at condition 23/18°C, depending on the application envisaged for the machine.

Regulation 2013/813 distinguishes two different types: at low temperature and at medium temperature.

The following refer to the application at low temperature: (low temperature application) all heat pumps whose maximum delivery temperature for heating purposes is lower than 52°C with source at temperature of -7°C and -8°C wet bulb (air-water unit) or inlet 10°C (water-water unit), at the reference design conditions for an average climate.For these, the efficiency ratio is "low temperature application" (outlet water temperature 35°C).

For all the other heat pumps, the efficiency ratio is related to "medium temperature application" (outlet water temperature 55°C).

The ratios must be calculated according to the reference European heating season in average climatic conditions.

The minimum efficiency requirements set by the regulations are indicated below.

REGULATION 2016/2281, comfort application

TYPE OF UNIT		MINIMUM REQUIREMENT			
		Tier 1		Tier 2 (2021)	
SOURCE	**Pdesign**	**ηsc [%]**	**SEER**	**ηsc [%]**	**SEER**
air	< 400kW	149	3,8	161	4,1
air	≥ 400kW	161	4,1	179	4,55
water	< 400kW	196	5,1	200	5,2
water	≥ 400kW and < 1500kW	227	5,875	252	6,5
water	≥ 1500kW	245	6,325	272	7

REGULATION 2016/2281, process application

TYPE OF UNIT		MINIMUM REQUIREMENT	
		Tier 1	Tier 2 (2021)
SOURCE	**Pdesign**	**SEPR**	**SEPR**
air	< 400kW	4,5	5
air	≥ 400kW	5	5,5
water	< 400kW	6,5	7
water	≥ 400kW and < 1500kW	7,5	8
water	≥ 1500kW	8	8,5

REGULATION 2013/813

SOURCE	APPLICATION	MINIMUM REQUIREMENT	
		ηsh [%]	**SCOP**
air	low temperature application	125	3,2
water	low temperature application	125	3,325
air	medium temperature application	110	2,825
water	medium temperature application	110	2,95

The conformity of the product must be checked according to the type of application, whether comfort or process, and at the required outlet water temperature.
The two schematic tables below, respectively for comfort application and for process application, indicate the reference of the required conformity according to the type of product and the set point temperature (reference to regulations 2016/2281 and 2013/813).
Important note: for mixed comfort and process applications, the reference application for conformity is the comfort application.

COMFORT APPLICATION

PRODUCT	OUTLET WATER TEMPERATURE	COMPLIANCE INDEX	REGULATION
Chiller	< 18°C	SEER/ηsc low temperature application	2016/2281
	≥ 18°C	SEER/ηsc medium temperature application	2016/2281
Heat pumps (reversible and only heating) Pdesign≤400kW		SCOP/ηsh	2013/813
Reversible heat pumps Pdesign>400kW	< 18°C	SEER/ηsc low temperature application	2016/2281
	≥ 18°C	SEER/ηsc medium temperature application	2016/2281
Heat pumps only heating Pdesign>400kW		-	-

PROCESS APPLICATION

PRODUCT	OUTLET WATER TEMPERATURE	COMPLIANCE INDEX	REGULATION
Chiller	≥ +2°C , ≤ 12°C	SEPR	2016/2281
	> 12°C	-	-
	> -8°C , < +2°C	-	-

- = exemption from Ecodesign

Some specifications and notes follow.

Partly completed machinery

The term partly completed machinery refers to all units without a user-side or source-side heat exchanger, and therefore to all LC, LE, LC/HP and LE/HP versions. Since these are "non-complete" machines, conformity with Ecodesign depends on combination with the remote heat exchanger.

All the partly completed machinery is CE marked and accompanied by a declaration of conformity. Installation in European Union countries is therefore allowed; correct selection and installation of the remote heat exchanger must be ensured, in accordance with the above cases.

EC fans:

The only option that positively affects the performance of the unit, by increasing its seasonal energy efficiency ratio, is the VEC accessory.

A unit equipped with EC fans has a higher SEER (ηsc) than the configuration with standard fans.

TETRIS W REV FC / NG RANGE

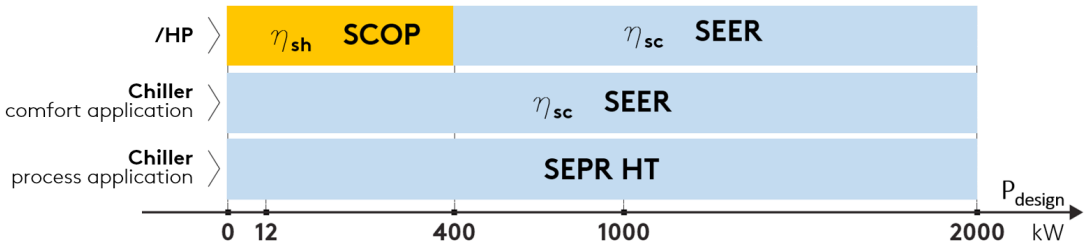
The Ecodesign/ErP Directive (2009/125/EC) lays down new standards for more efficient energy use.
Several regulations are part of the directive, and set mandatory seasonal efficiency targets for sale in the European Union.
The unit therefore, to be CE marked and sold in the EU market, must comply with the minimum requirements imposed by the regulations in question.
As for the Tetris W Rev FC / NG, in the different configurations, the regulations of interest are as follows:

- Regulation 2016/2281, for chillers with Pdesign> 400 kW

Minimum efficiency requirements are imposed through seasonal energy efficiency indices, respectively:

- ηsc (SEER) for comfort applications and SEPR for process applications, with reference to regulation 2016/2281

As regards the 2016/2281 regulation starting from 1 January 2021, the minimum required efficiency limit will be raised (Tier 2) compared to the current standard (Tier 1).



Tetris W Rev FC/NG:

- chiller version: regulation 2016/2281.

The tables below give information on the conformity of the units and the seasonal energy performance ratios with regard to the reference regulation.

TETRIS W REV FC/NG

			3.2	4.2	5.2	6.2	7.2	8.2	9.2
REGULATION 2016/2281									
Pdesign	(1)	kW	38,2	43,4	49,8	55,2	64	71,9	82
COMFORT									
ηsc	(1)	%	201,2	201,3	200,8	202,6	201,7	205,6	200,9
SEER	(1)		5,23	5,23	5,22	5,27	5,24	5,34	5,22
Compliance Tier 1	(1)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(1)		Y	Y	Y	Y	Y	Y	Y
PROCESS									
SEPR	(2)		7,19	7,24	7,25	7,25	7,25	7,26	7,09
Compliance Tier 1	(2)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(2)		Y	Y	Y	Y	Y	Y	Y

Y = unit in compliance with Ecodesign at the indicated condition.

N = unit not in compliance with Ecodesign at the given condition: it can be installed only in non-EU countries.

(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

(2) User-side heat exchanger water inlet/outlet temperature 12/7°C, with reference to regulation 2016/2281 and norm EN 14825.

TETRIS W REV FC/NG

			10.2	12.2	13.2	15.2	17.2	19.2	20.2
REGULATION 2016/2281									
Pdesign	(1)	kW	99,6	113	130,5	144,3	160,5	181,9	199,5
COMFORT									
ηsc	(1)	%	200	206,3	201,5	201,2	200,5	205,8	200,7
SEER	(1)		5,2	5,36	5,24	5,23	5,21	5,35	5,22
Compliance Tier 1	(1)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(1)		Y	Y	Y	Y	Y	Y	Y
PROCESS									
SEPR	(2)		7,19	7,13	7,15	6,95	6,95	7	6,82
Compliance Tier 1	(2)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(2)		Y	Y	Y	N	N	N	N

Y = unit in compliance with Ecodesign at the indicated condition.

N = unit not in compliance with Ecodesign at the given condition: it can be installed only in non-EU countries.

(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

(2) User-side heat exchanger water inlet/outlet temperature 12/7°C, with reference to regulation 2016/2281 and norm EN 14825.

			24.2	27.2	30.3	34.3	40.3	18.4	20.4
REGULATION 2016/2281									
Pdesign	(1)	kW	221,3	250,7	309,2	323,7	383,5	162,6	196,8
COMFORT									
ηsc	(1)	%	215,7	213	215,2	221,3	216,8	215,4	222,5
SEER	(1)		5,59	5,53	5,58	5,73	5,62	5,59	5,76
Compliance Tier 1	(1)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(1)		Y	Y	Y	Y	Y	Y	Y
PROCESS									
SEPR	(2)		7,29	7,29	7,02	7,3	7,4	7,26	7,28
Compliance Tier 1	(2)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(2)		Y	Y	Y	Y	Y	Y	Y

Y = unit in compliance with Ecodesign at the indicated condition.

N = unit not in compliance with Ecodesign at the given condition: it can be installed only in non-EU countries.

(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

(2) User-side heat exchanger water inlet/outlet temperature 12/7°C, with reference to regulation 2016/2281 and norm EN 14825.

			24.4	26.4	30.4	34.4	37.4	38.4	39.4
REGULATION 2016/2281									
Pdesign	(1)	kW	224,7	253,1	286,8	319	361,8	363,3	423,1
COMFORT									
ηsc	(1)	%	218,5	220,1	216,2	209,8	212,1	212,1	228,4
SEER	(1)		5,66	5,7	5,61	5,45	5,50	5,5	5,91
Compliance Tier 1	(1)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(1)		Y	Y	Y	Y	Y	Y	N
PROCESS									
SEPR	(2)		7,23	7,22	7,04	6,94	7,43	6,99	7,5
Compliance Tier 1	(2)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(2)		Y	Y	Y	N	Y	N	N

Y = unit in compliance with Ecodesign at the indicated condition.

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(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

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TETRIS W REV FC/NG

			40.4	47.4	48.4	53.4	54.4	55.6	56.6
REGULATION 2016/2281									
Pdesign	(1)	kW	408,4	467,6	453,8	526,7	521,9	563,1	544,8
COMFORT									
ηsc	(1)	%	228,4	231,4	231,2	229,9	229,9	227,4	227,4
SEER	(1)		5,91	5,98	5,98	5,95	5,95	5,89	5,89
Compliance Tier 1	(1)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(1)		N	N	N	N	N	N	N
PROCESS									
SEPR	(2)		7,5	7,51	7,57	7,53	7,61	7,52	7,5
Compliance Tier 1	(2)		Y	Y	Y	Y	Y	Y	Y
Compliance Tier 2 (2021)	(2)		N	N	N	N	N	N	N

Y = unit in compliance with Ecodesign at the indicated condition.

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(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

(2) User-side heat exchanger water inlet/outlet temperature 12/7°C, with reference to regulation 2016/2281 and norm EN 14825.

			59.6	60.6
REGULATION 2016/2281				
Pdesign	(1)	kW	633,9	615
COMFORT				
ηsc	(1)	%	227,2	227,2
SEER	(1)		5,88	5,88
Compliance Tier 1	(1)		Y	Y
Compliance Tier 2 (2021)	(1)		N	N
PROCESS				
SEPR	(2)		7,51	7,53
Compliance Tier 1	(2)		Y	Y
Compliance Tier 2 (2021)	(2)		N	N

Y = unit in compliance with Ecodesign at the indicated condition.

N = unit not in compliance with Ecodesign at the given condition: it can be installed only in non-EU countries.

(1) User-side heat exchanger water inlet/outlet temperature 12/7°C (low temperature application), with reference to regulation 2016/2281 and standard EN 14825.

(2) User-side heat exchanger water inlet/outlet temperature 12/7°C, with reference to regulation 2016/2281 and norm EN 14825.

INSTALLATION ADVICE

The units described in this document are, by nature, strongly affected by the characteristics of the system, the working conditions and the installation site.

Remember that the unit must be installed by a qualified and skilled technician, and in compliance with the national legislation in force in the destination country.

The installation must be done in such a way that it will be possible to carry out all routine and non-routine maintenance operations.

Before starting any work, you must carefully read the "Installation, operation and maintenance manual" of the machine and do the necessary safety checks to prevent any malfunctioning or hazards.

We give some advice below that will allow you to increase the efficiency and reliability of the unit and therefore of the system into which it is inserted.

Water characteristics

To preserve the life of the exchangers, the water is required to comply with some quality parameters and it is therefore necessary to make sure its values fall within the ranges indicated in the following table:

Total hardness	2,0 ÷ 6,0 °f
Langelier index	- 0,4 ÷ 0,4
pH	7,5 ÷ 8,5
Electrical conductivity	10÷500 µS/cm
Organic elements	-
Hydrogen carbonate (HCO3-)	70 ÷ 300 ppm
Sulphates (SO42-)	< 50 ppm
Hydrogen carbonate / Sulphates (HCO3-/SO42-)	> 1
Chlorides (Cl-)	< 50 ppm
Nitrates (NO3-)	< 50 ppm
Hydrogen sulphide (H2S)	< 0,05 ppm
Ammonia (NH3)	< 0,05 ppm
Sulphites (SO3), free chlorine (Cl2)	< 1 ppm
Carbon dioxide (CO2)	< 5 ppm
Metal cations	< 0,2 ppm
Manganese ions (Mn++)	< 0,2 ppm
Iron ions (Fe2+ , Fe3+)	< 0,2 ppm
Iron + Manganese	< 0,4 ppm
Phosphates (PO43-)	< 2 ppm
Oxygen	< 0,1 ppm

Installation of water filters on all the hydraulic circuits is obligatory.

The supply of the most suitable filters for the unit can be requested as accessory. In this case, the filters are supplied loose and must be installed by the customer following the instructions given in the installation, operation and maintenance manual.

Glycol mixtures

With temperatures below 5°C, it is mandatory to work with water and anti-freeze mixtures, and also change the safety devices (anti-freeze, etc.), which must be carried out by qualified authorised personnel or by the manufacturer.

Liquid outlet temperature or minimum ambient temperature	°C	0	-5	-10	-15	-20	-25	-30	-35	-40
Freezing point	°C	-5	-10	-15	-20	-25	-30	-35	-40	-45
Ethylene glycol	%	6	22	30	36	41	46	50	53	56
Propylene glycol	%	15	25	33	39	44	48	51	54	57

The quantity of antifreeze should be considered as % on weight

Minimum water content in the system

For correct operation of the unit, it is necessary to ensure a buffering on the system such as to comply with the minimum operating time considering the greater between the minimum OFF time and the minimum ON time. In short, these contribute to limiting the number of times the compressors are switched on per hour and to preventing undesired deviations from the set point of the delivered water temperature.
The following experimental formula allows the minimum water volume of the system to be calculated:

$$V_{min} = \frac{P_{tot} \cdot 1.000}{N} \cdot \frac{300}{\Delta T \cdot \rho \cdot c_p} + P_{tot} \cdot 0{,}25$$

where
Vmin is the minimum water content of the system [l]
Ptot is the total cooling capacity of the machine [kW]
N: number of capacity reduction steps
ΔT: differential allowed on the water temperature. Unless otherwise specified, this value is considered to be 2.5K
ρ: density of the heat-carrying fluid. Unless otherwise specified, the density of water is considered
cp: specific heat of the heat-carrying fluid. Unless otherwise specified, the specific heat of water is considered
Considering the use of water and grouping together some terms, the formula can be re-written as follows:

$$V_{min} = \frac{P_{tot}}{N} \cdot 17{,}2 + P_{tot} \cdot 0{,}25$$

N is equal to the number of compressors installed in the unit.

Installation site

To determine the best installation site for the unit and its orientation, you should pay attention to the following points:

- compliance with the clearance spaces indicated in the official dimensional drawing of the unit must be guaranteed so as to ensure accessibility for routine and non-routine maintenance operations
- you should consider the origin of the hydraulic pipes and their diameters because these affect the radiuses of curvature and therefore the spaces needed for installing them
- you should consider the position of the cable inlet on the electrical control panel of the unit as regards the origin of the power supply
- if the installation includes several units side by side, you should consider the position and dimensions of the manifolds of the heat exchangers

Once the best position for the unit has been identified, you must check that the support slab has the following characteristics:

- its dimensions must be proportionate to those of the unit: if possible, longer and wider than the unit by at least 30 cm and 15/20cm higher than the surrounding surface
- it must be able to bear at least 4 times the operating weight of the unit
- must allow the unit to be installed in a level position

The units are designed and built to reduce to a minimum the level of vibration transmitted to the ground, but it is in any case advisable to use rubber or spring anti-vibration mounts, which are available as accessory and should be requested when ordering.
The anti-vibration mounts must be fixed to the machine before positioning the unit on the ground.

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