MITSUBISHI ELECTRIC
HYDRONICS & IT COOLING SYSTEMS S.p.A.

Technical Bulletin
i-FR-W (1+i)-G05-Z 1402 - 4252_201811_EN HFC R513A
ELCA_Engine ver.4.1.1.0

COOLING

i-FR-W (1+i)-G05-Z 1402 - 4252

High efficiency water cooled chiller

R513A
SCREW
FLOODED
EUROVENT CERTIFIED PERFORMANCE www.eurovent-certification.com
VPF VARIABLE PRIMARY FLOW
VSPEED VARIABLE SPEED DRIVE
GREEN CERTIFICATION RELEVANT

(The photo of the unit is indicative and may vary depending on the model)

- HIGH EFFICIENCY
- FLEXIBILITY
- TOTAL VERSATILITY
- MAXIMUM COMPACTNESS

CERTIFICATIONS

Product certifications

Voluntary product certifications

Check ongoing validity of certificate:
www.eurovent-certification.com
or
www.certiflash.com

System certifications

MITSUBISHI ELECTRIC HYDRONICS & IT COOLING SYSTEMS S.p.A.

Quality System complying with the requirements of UNI EN ISO 9001:2008 regulation
Environmental Management System complying with the requirements of UNI EN ISO 14001:2004 regulation
Occupational Health and Safety Management System complying with the requirements of BS OHSAS 18001:2007

INDEX **i-FR-W (1+i)-G05-Z 1402 - 4252**

The units highlighted in this publication contain R513A [GWP_{100} 631] fluorinated greenhouse gases.

Functions

COOLING — Cooling

Refrigerant

R R513A — R513A

Compressors

SCREW — Screw compressor

Exchangers

FL FLOODED — Flooded evaporator

Other features right position

A ENERGY CLASS — Energy Class A

Other features

EUROVENT CERTIFIED PERFORMANCE www.eurovent-certification.com — Eurovent

VPF VARIABLE PRIMARY FLOW — VPF

VSPEED VARIABLE SPEED DRIVE — VSpeed

GREEN CERTIFICATION RELEVANT — GREEN Certification relevant

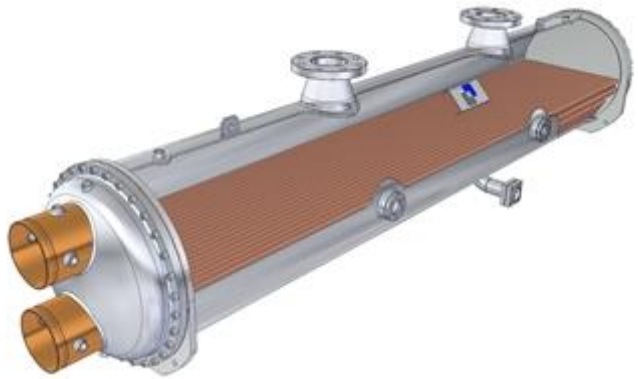
1.2 The highest efficiency in every load condition
New (1+i) units feature a new concept of efficiency: a fixed speed compressor + a variable speed compressor (+i) in the same unit and in the same circuit.

The unique and advanced control logics improve the best features and benefits of each compressor. The result is a unit that focuses on efficiency in all load conditions, overcoming the limitations traditionally imposed at full load from full inverter systems and at partial loads from fixed speed screw compressors.
The advantages of the new logic (1+i):
- two compressors in the same circuit, in order to guarantee the maximum efficiency benefit at part loads
- in every load condition, only the best combination of compressors is called to work
- efficiency beyond class A at full load and ESEER of 8,54 (ESEER 7,53 according to EN14511, IPLV 8,63)
- continuous modulation from 18% to 100% ensures perfect stability on leaving water temperature.

1.3 The best solution for all types of applications
The new (1+i) units feature smart characteristics:
- the high efficiency levels
- the large modulation capacity
- the direct control of operating parameters
- the wide operating area
- the fast re-start option
- the refrigerant leak detection option
- the enhanced configurability
- the compressors soundproofing
make it a product perfect for both comfort and process cooling applications.

1.4 Innovative design of the heat exchangers
The exclusive design of the flooded evaporator and of the shell and tube condenser, both designed and manufactured by MEHITS, maximizes the cooling power of the unit and optimizes the compressors' operation thanks to the high heat exchange coefficients.
In the evaporator the presence of the refrigerant in the shell side and of the water inside the tubes allows to:
- minimize the pressure drops
- gain a perfect temperature uniformity as well as the complete evaporation of the refrigerant
- cancel any necessity to have heat surfaces dedicated to desuperheating
- facilitate cleaning operations

The flooding of the tubes in the evaporator is controlled by an electronic expansion valve managed but proprietary control logics.



1.5 Maximum flexibility and adaptability
Maximum flexibility and adaptability to the needs of the plant thanks to:
- continuous modulation of the cooling capacity, guaranteed by sophisticated regulation logics
- precision and quickness in the control, in order to guarantee stable water temperature
- management of the variable flow using the VPF or VPF.D signal
- pressure drops reduction, thanks to particular layout for the flooded evaporator
- compact and essential design, achieved by the construction layout, without base, frame structure and panels. The components are directly fixed on one another, through fixing brackets
- movimentation and on site placement easiness, even in case of small spaces, added to immediate and complete accessibility during maintenance operations

1.6 Continuous modulation of cooling capacity
The new logic (1+i) has been developed in this family range to manage in the same circuit both the fixed speed compressor and the variable speed one.
The logic (1 + i) calls in function always and only the best combination of available resources, giving priority to the point of maximum compressors efficiency and realizing the linearization in the cooling capacity supplied by the unit.
The results are the total adaptability to the load, with a continuous modulating capacity from 18% to 100%, the stability in the leaving water temperature, the supply of a cooling load at the highest levels of efficiency even under conditions of high partial load .
The stability in the leaving water temperature and the high efficiency are obtained thanks to algorythms that emphasize the direct control of the operating parameters.
The factory setting is modulating with PID (proportional integral derivative) logic in the temperature of the water leaving the evaporator.

1.7 Lubricant recovery
An innovative lubricant oil recovery system from the exchangers, combined with the traditional built-in oil separator, allows the compressors to work always with the correct and appropriate lubification and at the same time enables the exchange surfaces of the heat exchanger to stay clean, ensuring reliability to the entire system.

1.8 Fast RE-START
The new logic (1+i) can also manage the fast restart of the resources following a loss of power supply and this is performed without any risk for the unit safety. As soon as the control system detects that the outlet water temperature is getting close to the set value, the fast "request" of resources is interrupted in order to avoid undesired temperature variations.
The fast-restart function requires external power supply by UPS (230V AC 300VA) to be provided for by the customer.
(RFQ option: it's necessary to ask tou our sales department for the feasibility and the quotation)

1.9 Refrigerant leak detection
With i-FX-W innovation and efficiency follow closely the environment care, also thanks to a refrigerant leak detection system, that detects if there's any gas inside the plant room where the unit is installed, available in 3 variants:
- device supplied lose, it has to be installed by others close to the unit. In case of leak detection it raises an alarm.
- device factory mounted and wired in the electrical board. In case of leak detection it raises an alarm.
- refrigerant leak detection and migration system. The leak detector is supplied factory mounted and wired in the electrical board. Moreover some additional valves are fitted in the frigorific circuit. In case the device detects a leakage the unit stops and stores the remaining refrigerant inside the evaporator.
The presence of this accessory helps to gain Leed points.
(For some sizes the option could not be compatible with container delivery. For any further information please ask to our sales office.)

GREEN CERTIFICATION RELEVANT

Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A., as a major player in the world HVAC market and a leading manufacturer of energy efficient, sustainable HVAC solutions, recognizes and supports the diffusion of green certification systems, as an effective way to deliver high performance buildings and improve the quality and the sustainability of the built environment.

Since the first certification system was introduced at the beginning of the 1990s, the demand for certified buildings has grown considerably, as well as the number of standards, rating and certification programs. Operating worldwide Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A., has extensive experience with many of them and is active member of Green Building Council Italy.

Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A., commitment to develop responsible and sustainable HVAC solutions, is reflected by a full range of premium efficiency products and systems, designed with special care to improve building energy performance ratings, according to major certification protocols, including LEED, BREAM, GREENSTAR, BCA, NABERS, DNGB, HQE and BEAM.

To find out more about how our products contribute to enhanced green certification rating and energy performance of a building, please refer to:
https://www.melcohit.com/GLOBAL/Company/Green-Certifications/QR%20code/

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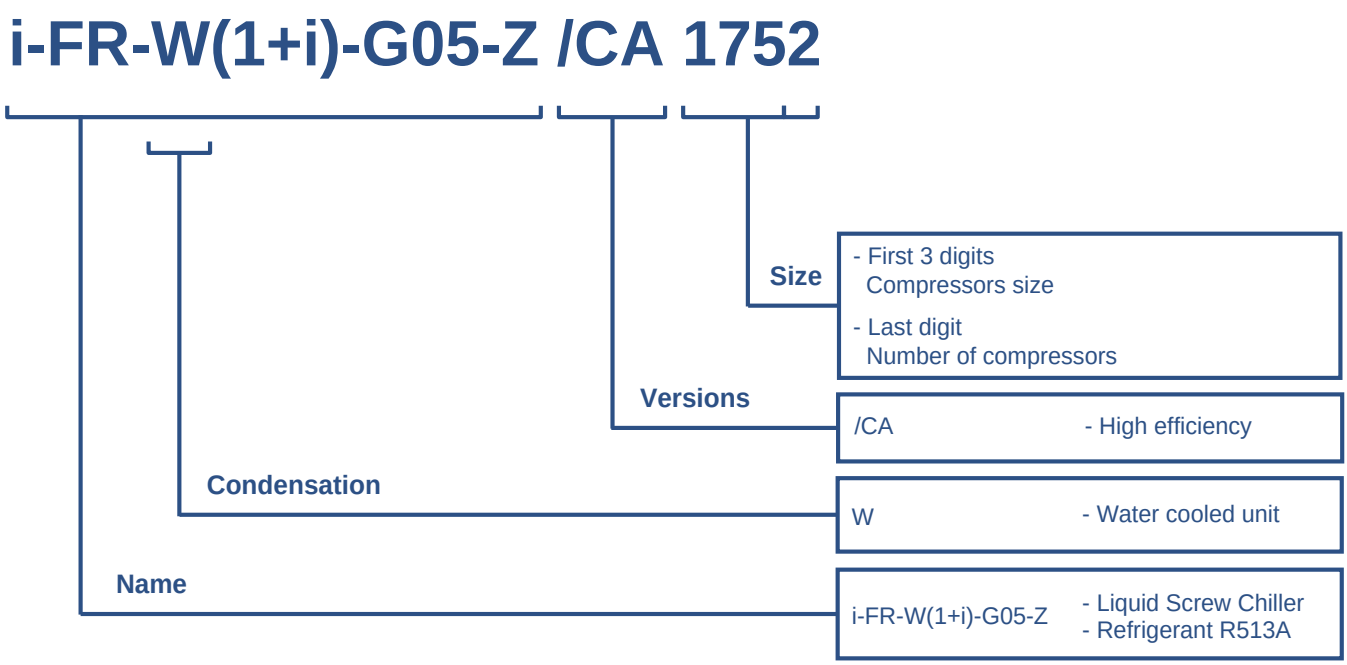

i-FR-W(1+i)-G05-Z /CA 1752
Size
- First 3 digits
Compressors size
- Last digit
Number of compressors
Versions
/CA
- High efficiency
Condensation
W
- Water cooled unit
Name
i-FR-W(1+i)-G05-Z
- Liquid Screw Chiller
- Refrigerant R513A

Single circuit indoor unit for the production of chilled water, with fixed speed and variable speed (Inverter Driven) screw compressors optimized for R513A, electronic expansion valve, high performing shell and tube condenser and shell and tube flooded evaporator, both designed and produced by Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A. These technological solutions enhance the EER values over 5,7 at Eurovent standard conditions.
The resulting unit is extremely compact, thanks to the strategic layout, designed without base, frame and panels.

2.3 HIGH EFFICIENCY
Unit with high efficiency and reduced energy consumption, thanks to the inverter technology, contributing to lower operating costs and therefore achieving a quick return on investment.

2.4 FLEXIBILITY
Unit featured by remarkable application flexibility thanks to the inverter tecnology which allows to obtain, taking in consideration the cooling capacity needed, the best result about costs/performances and maximum efficiency.

2.5 TOTAL VERSATILITY
Unit designed gathering in a single circuit a compressor with step regulation and one working with inverter, in order to guarantee the best answer to plant necessities both at full and at part loads.

2.6 MAXIMUM COMPACTNESS
Maximum compactness to achieve a very high flexibility in the design process and installation operations, offering a premium solution in case of reduced clearances or when retrofitting existing installations.

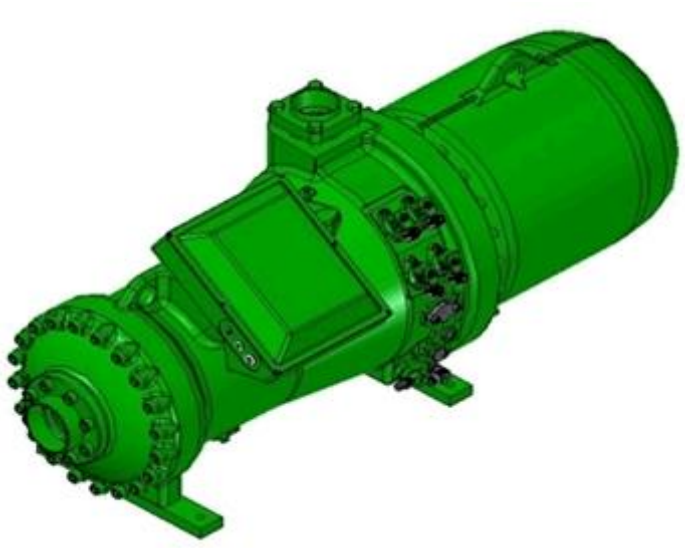
3.2 High efficiency water cooled chiller
Single circuit indoor unit for the production of chilled water, with fixed speed and variable speed (Inverter Driven) screw compressors optimized for R513A, electronic expansion valve, high performing shell and tube condenser and shell and tube flooded evaporator, both designed and produced by Climaveneta. These technological solutions enhance the EER values over 5,7 at Eurovent standard conditions.
The resulting unit is extremely compact, thanks to the strategic layout, designed without base, frame and panels.

3.3 Installation note
The unit is supplied fully refrigerant charged and factory tested. On site installation only requires power and hydraulic connection.

3.4 Refrigerant circuit
Unit designed with 2 compressors in a single refrigerant circuit optimizing the heat exchange's process, especially in part load mode, without any risk in the proper management of oil, thanks to the peculiar arrangements included inside each exchanger.
Standard components of the refrigerant circuits are:
- check valve on the compressor delivery line
- liquid line shut-off device (function performed by electronic expansion valve with ultracap)
- drier filter with replaceable cartridge
- refrigerant line sight glass with humidity indicator
- electronic expansion valve
- high and low pressure safety valve
- safety switching device for limiting the pressure
- high and low pressure transducers
- modulating signale 0-10V for condensing pressure control (max 30m)

3.5 Compressors' configuration
Exclusive semi-hermetic screw compressors driven by constant-speed and variable-speed motors (inverters) designed to ensure high performance in any load condition.
The logic adjusting the use of resources (1+i) has been specifically worked out so that, when the unit is started, the inverter compressor is always the first one to start, with consequent reduction of the starting currents, and it is also the last one to cut out.
In this way, the requested cooling capacity is continuously supplied and the perfect stability of outlet water temperature is ensured.
Added to this, depending on the required load condition, the logic privileges the most efficient combination between constant-speed compressor and variable-speed compressor (thanks to the continuous adjustment of the inverter compressor and to the three-step adjustment of the constant-speed compressor).

3.6 Compressor
New semi-hermetic screw compressors designed for high efficiency in low condensing temperature applications.
Semi-hermetic screw compressors with 2 five- and six-lobe rotors: the five-lobe rotor is splined directly onto the motor (nominal speed 2950 rpm) without the use of interposed gears. The bearings provided along the rotor axis in a separate chamber isolated from the compression chamber, are made in carbon steel. Each compressor is provided with two entrances for the oil recovery from the exchangers. The built-in oil separator has 3 stages of separation, and a 10 mm stainless steel mesh filter ensures the constant presence of oil inside. Cooling power is partialized by a slide valve, which depending on the position assumed, permits a stepless compression chamber reduction; each compressor can therefore partialize in three steps: 100%, 75% and 50%. The two pole motors are fitted as standard with electric devices to limit the absorbed current during compressor start-up, and with unloaded start-up. Each compressor is fitted with manual-reset motor thermal protection, delivery gas temperature and oil level controls and an electric resistance for the carter´s heating while the compressor is stopped. A check valve fitted on the refrigerant delivery line prevents the rotors from reversing after stopping. On-off cock on the delivery line of each compressor (external to the compressor itself) to isolate the refrigerant charge in the heat exchanger when required.



3.7 Inverter
High efficiency frequency inverter, characterized by a compact design and maximum accessibility, designed on purpose for compressors' control in refrigeration applications, supplied with built-in display and keyboard. The operation is guaranteed without any declassing up to an ambient temperature of 50°C. The cooling, divided between power part and electronic part, is guaranteed by a double ventilation system. The device is characterized by a stable and highly dinamic behaviour, even in case of short voltage drops or when the network conditions are not ideal. The compressor's motor is therefore protected from dangerous loads due to electronic overloads, guaranteeing so a longer lifetime even if under hard working conditions.

3.8 Plant side heat exchanger
Shell and tube heat exchanger, fully designed and manufactured by MEHITS, working as flooded type evaporator, with water flowing inside the pipes and refrigerant flowing in the shell side. The steel shell is insulated with a foamed polyethylene closed-cell mat of 9 mm thickness and a thermal conductivity of 0,033 W/mK at 0°C. The copper pipes are internally and externally grooved in order to improve the heat exchange. Integrated system to avoid liquid entrainment and to protect the compressor against the risk of liquid suction. A differential pressure switch is fitted in order to control the water flow while the unit is working, avoiding the risk of ice generation. An electric heater, operating when antifreezing mode is active, is present on the shell. The pipes' flooding is controlled by an electronic expansion valve, managed by proprietary logics to guarantee the proper refrigerant flow and the complete flooding of pipes in all conditions of compressors' load. The heat exchanger complies with PED standards, concerning the operating pressures.

3.9 Source side heat exchanger
Shell and tube heat exchanger, fully designed and manufactured by MEHITS, working as condenser, with water flowing inside and refrigerant flowing outsider the pipes. The steel shell is insulated with a foamed polyethylene closed-cell mat. The copper pipes are internally and externally grooved to improve heat exchange. Heads can be removed to inspect the pipes. The heat exchanger complies with PED standards, concerning the operating pressures.

3.10 Electrical and control panel
Electrical and control panel built to EN60204-1 and EC204-1 standards, complete with:
- star/delta compressors' start up (for fixed speed compressor only)
- phases sequence and minimum/maximum voltage control
- general door lock isolator
- power circuit with electric bus bar distribution system
- control circuit transformer
- remote ON/OFF terminals
- fuses and contactors for compressors
- terminals for cumulative alarm block
- compressors protection with internal thermal overload
- spring-type control circuit terminal board
- compressors' operation signal
- electronic controller
- cables' entrance from the top
- Electromagnetic compatibility according to EN 61000-6-4

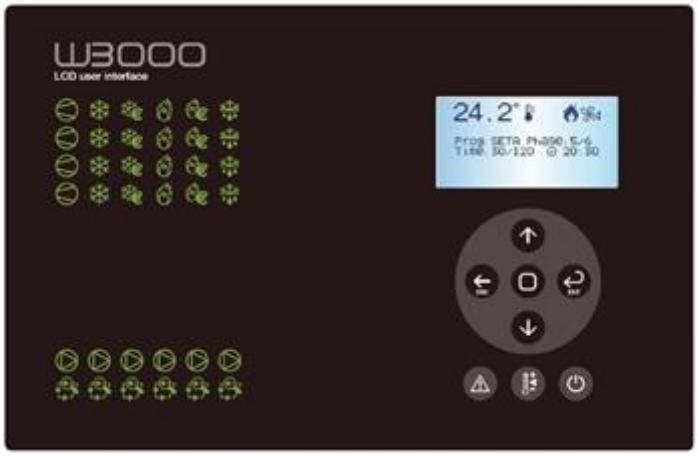
3.11 Certification and applicable directives

The unit complies with the following directives and relative amendments:
- EUROVENT Certification program
- CE Declaration of conformity certificate for the European Union
- Low Voltage directive 2006/95/EC
- ElectroMagnetic compatibility directive 2004/108/EC
- Machine directive 2006/42/EC
- PED directive 2014/68/EU
- ISO 14001 Company´s Environmental Management System certification
- ISO 9001 Company´s Quality Management System certification

3.12 Tests
Tests performed throughout the production process, as indicated in ISO9001.
Performance or noise tests can be performed by highly qualified staff in the presence of customers.
Performance tests comprise the measurement of:
- electrical data
- water flow rates
- working temperatures
- power input
- power output
- pressure drops on the water-side exchanger both at full load (at the conditions of selection and at the most critical conditions for the condenser) and at part load conditions.

During performance testing it is also possible to simulate the main alarm states.
Noise tests are performed to check noise emissions according to ISO9614.

3.13 Electronic control W3000 TE
The brand new W3000TE controller offers advanced functions and algorithms. The large format keyboard and the wide LCD display favour an easy and safe access to the machine setup and a complete view of unit's staus. The assessment and intervention on the unit is managed through a multi-level menu, with selectable user's language. The led icons immediately show the operating status of the circuits, as well as of the fans and of the water pumps (if present). An optional extra is the touch screen interface: 7.0" WVGA colour display with adjustable LED backlight and front USB port. The touch screen technology allows intuitive navigation between the various screens, safe access to the data with a three-level password protection as well as the graphic display of the performance of some monitored measurements.
The diagnostics comprises a complete alarm management system, with "black box" (via PC) and alarm log functions (via display or also PC) for a better analysis of the unit performance.
For the systems made of several units, the adjustment of the resources is performed by optional proprietary devices.
Consumption metering and performance measurement are possible as well. Supervision can be easily developed via proprietary devices or the integration in third party systems by means of the most common protocols as ModBus, Bacnet-over-IP, Echelon LonWorks, Bacnet MS/TP protocols.
Compatibility with the remote keyboard managing up to 8 units.
The presence of the programmable timer allows the creation of an operating profile containing up to 4 typical days and 10 time bands.
The control is characterized by the continuous modulation of the unit capacity, based on PID algorithms and referring to the water delivery temperature.
Optionally (VPF package), capacity modulation can be integrated with hydraulic flow modulation, thanks to inverter-driven pumps and to specific resources for the hydraulic circuit.



3.13 Touch screen
Touch screen interface

3.14 Versions
/CA - Class A of efficiency
Unit in ´Class A´ of efficiency as per Eurovent.

3.15 Configurations
- , standard unit
Standard unit for production of chilled water

4.1 OPTIONS

OPTIONS	DESCRIPTIONS	BENEFITS	AVAILABLE FOR MODELS
1020 REGULATIONS			
1015 HEAT EXCHANGERS NSW CERTIFIED	Heat exchangers with SafeWork NSW certificate		ALL
1960 PRESSURE RELIEF VALVES			
1961 DUAL RELIEF VALVES WITH SWITCH	Dual relief valve with switch	Allows to unselect a relief valve in order to service the unit avoiding medium or long inoperative periods	ALL
380 NUMBERED WIRING			
381 NUMBERED WIRING ON EL. BOARD	Electrical board wires are identified by numbered labels. The reference numbers are indicated in the unit's wiring scheme.	Facilitate maintainance interventions to the electrical board connections.	ALL
3300 COMPRESSOR REPHASING			
3301 COMPR.POWER FACTOR CORR.	Capacitors on the compressors' power inlet line.	The unit's average cos(phi) increases.	ALL
3410 AUTOMATIC CIRCUIT BREAKERS			
3412 AUTOM. CIRCUIT BREAK. ON LOADS	Over-current switch on the major electrical loads.	In case of overcurrent allows resetting of the switch without the replacement of relative fuses.	ALL
3600 ON/OFF COMPRESSOR SIGNAL			
3601 COMPRESSOR OPERATION SIGNAL	Auxiliary contacts providing a voltage-free signal.	Allows remote signalling of compressor's activation or remote control of any auxiliary loads.	ALL
4180 REMOTE CONNECTION ARRANGEMENT			
4181 SERIAL CARD MODBUS	Interface module for ModBUS protocols.	Allows integration with BMS operating with ModBUS protocol.	ALL
4182 SERIAL CARD FOR LONWORKS	Interface module for Echelon systems.	Allows integration with BMS operating with LonWorks protocols	ALL
4184 SERIAL CARD BACNET MS/TP RS485	Interface module for BACnet protocols.	Allows integration with BMS operating with BACnet protocol.	ALL
4185 SERIAL CARD FOR BACNET OVER IP	Interface module for BACnet OVER-IP protocols.	Allows to interconnect BACnet devices over Internet Protocol within wide-area networks.	ALL
4187 M-Net W3000 INTERFACE KIT	Interface kit for M-Net protocol.	Interface module to allow the integration of the unit with Mitsubishi Electric proprietary communication protocol M-Net.	ALL
6160 AUXILIARY INPUT			
6161 AUXILIARY SIGNAL 4-20mA	4-20 mA analog input	Allows to change the operating set-point according to the value of current applied to the analogue input.	ALL
6162 REMOTE SIGNAL DOUBLE SP	Allows to activate the Energy Saving set-point.	Allows to change the operating set-point according to a remote switch	ALL
6170 DEMAND LIMIT			
6171 INPUT REMOTE DEMAND LIMIT	Digital input (voltage free)	It permits to limit the unit's power absorption for safety reasons or in temporary situation.	ALL

OPTIONS

OPTIONS	DESCRIPTIONS	BENEFITS	AVAILABLE FOR MODELS
6190 **TYPE OF VISUAL DISPLAY**			
6195 7 INCH TOUCH SCREEN	The unit is equipped with the Touch interface, with a 7" WVGA colour display and a front USB port (WARNING: with outdoor temperature below 0°C the display response time may visibly increase).	The touch-screen's technology is characterized by an easy-to-access data, and it allows an effective graphical representation of the main figures protecting the access through 3 privilege levels.	ALL
1510 **SOFT-STARTER**			
1511 UNIT WITH SOFT-START	Electronic device adopted to manage the inrush current.	Break down of the inrush current compared to the direct motor start, lower motor windings' mechanical wear, avoidance of mains voltage fluctuations during starting, favourable sizing for the electrical system.	ALL
3350 **WATER FLOW REGULATION :**			
3351 WITH VPF SYSTEM (SIG. 0-10V)	Pre-arrangement for the control of the inverter driven pumps for the plant's primary circuit (see dedicated section). This option includes: differential pressure transducer on the evaporator, additional control devices to read the signals (4-20 mA) coming from the differential pressure transducers on the evaporator and on the plant and to manage the pumps and the by-pass valve (0-10V signals). [Plant differential pressure transducers, pumps and by-pass valve to be supplied by others].	Energy consumption associated with fluid circulation drops significantly, very often over 50%. Beyond the energy saving and the consequent lower operating costs, this new approach enables simplification in the plant's design that ensures substantial savings in initial investment costs. The integration of variable flow pumps on board, permits significant savings in overall dimensions, circuit components and in the system's commissioning.	ALL
3352 WITH VPF.D SYSTEM (SIG. 0-10V)	Pre-arrangement for the control of the inverter driven pumps for the plant's primary circuit in installation with hydraulic decoupler (see dedicated section). This option includes: temperature sensors to be installed on the plant, additional control devices to read the signals (4-20 mA) coming from the plant temperature sensors and to manage the pump speed (0-10V signal). [Pumps to be supplied by others].	Energy consumption associated with fluid circulation drops significantly, very often over 50%. Beyond the energy saving and the consequent lower operating costs, this new approach enables simplification in the plant's design that ensures substantial savings in initial investment costs. The integration of variable flow pumps on board, permits significant savings in overall dimensions, circuit components and in the system's commissioning.	ALL
3360 **PUMPS COMAND RELAYS**			
3361 1 RELAY EVAPORATOR PUMP	Relay for the pump(s) on/off.	It controls the operation of 1 evaporator external pump with a devoted on/off signal.	ALL
3362 2 RELAYS EVAPORATOR PUMPS	Relay for the pump(s) on/off.	It controls the operation of 2 evaporator external pumps with 2 devoted on/off signals. The second pump operates in stand-by to the first. The relative operating hours of the two pumps are balanced.	ALL
3363 1 EVAP. + 1 COND. RELAY PUMPS	Relay for the pump(s) on/off.	It controls the operation of 2 evaporator external pumps with 2 devoted on/off signals. The second pump operates in stand-by to the first. The relative operating hours of the two pumps are balanced.	ALL
3364 2 EVAP. + 2 COND. RELAY PUMPS	Relay for the pump(s) on/off.	It controls the operation of 2 evaporator external pumps with 2 devoted on/off signals. The second pump operates in stand-by to the first. The relative operating hours of the two pumps are balanced.	ALL
3430 **REFRIGERANT LEAK DETECTOR**			
3431 REFRIG. LEAK DETECTOR	Refrigerant leak detection system, supplied factory mounted and wired in the electrical board. In case of leak detection it will raise an alarm.	It promptly detects gas leakages	ALL

OPTIONS

OPTIONS	DESCRIPTIONS	BENEFITS	AVAILABLE FOR MODELS
3432 REFRIG. LEAK DETECTOR+MIGR.	Refrigerant leak detection and migration system. In case the device detects a leakage the unit stops and stores the remaining refrigerant inside the evaporator, waiting for the intervention of a technician.	It promptly detects gas leakages, stops the unit and stores the remaining refrigerant.	ALL
3433 GAS LEAK CONTACT + COMPR. OFF	Refrigerant leak detection system, supplied factory mountedand wired in the electrical board. In case of leak detection it will raise an alarm and stop the unit.	It promptly detects gas leakages and stops the unit	ALL
3450 **ELECTR. COMP. AS IEC 61000-6**			
3451 EMC COMP. FOR RESIDENTIAL APP.	EMC compatibility for residential applications as per EN61000-6-3	Assure units' EMC compatibility as per EN61000-6-3, for residential, commercial and light industrial applications.	ALL
5920 **MANAGEMENT & CONTROL SYSTEMS**			
5921 NETWORK ANALYZER FOR DEMETRA	This option includes all following devices on-board the unit panel: - network analyzer operating on ModBUS protocol over RS-485 (without certification MID) - current transformers.	This accesory allows to acquire the electrical data and the power absorbed by the unit and send them via RS-485 bus to an external device for energy metering (DEMETRA - see dedicated manual).	ALL
5922 ClimaPRO ModBUS RS485 - MID	This option includes all following devices on-board the unit panel: - MID certified network analyzer operating on ModBUS over RS-485 - Current transformers - W3000TE controller - Software release LA09 or later version.	This accessory allows to acquire the electrical data and the power absorbed by the unit and communicate with ClimaPRO via high level communication interface based on ModBUS over EIA RS-485. More specifically, the data collected are: power supply, current, frequency, power factor ($\cos_\Phi$), electrical power consumption, energy consumption. This specific energy meter model is MID certified and can therefore be used for billing applications. This option also ensures the compatibility between the units and ClimaPRO, thus allowing ClimaPRO to acquire all the main unit's operating variables and status by means of a high level communication interface to the controller installed onboard the unit panel.	ALL
5923 ClimaPRO BacNET over IP	This option includes all following devices on-board the unit panel: - network analyzer operating on BACnet over IP - Current transformers - W3000TE controller - Software release LA09 or later version.	This accessory allows to acquire the electrical data and the power absorbed by the unit and communicate with ClimaPRO via high level communication interface based on BACnet over IP. More specifically, the data collected are: power supply, current, frequency, power factor ($\cos_\Phi$), electrical power consumption, energy consumption. This network analyzer is not MID certified and cannot therefore be used for billing applications. This option also ensures the compatibility between the units and ClimaPRO, thus allowing ClimaPRO to acquire all the main unit's operating variables and status by means of a high level communication interface to the controller installed onboard the unit panel.	ALL
1900 **COMPRESSOR SUCTION VALVE**			
1901 COMPRESSOR SUCTION VALVE	Shut-off valve on compressor's suction circuit.	Simplifies maintenance activities	ALL

OPTIONS

OPTIONS	DESCRIPTIONS	BENEFITS	AVAILABLE FOR MODELS
1950 **HIGH TEMPERATURE DEVICE**			
1953 KIT HWT	Kit for increased condenser leaving water temperature up to 60°C. To ensure control of the condenser leaving water temperature, this option must be fitted for /H function. NOTE: the adoption of "kit HWT" modifies the unit's performance in all the operating range; refer to the selection software to have the correct technical data.	The accessory is required for applications with high condensing temperature (heat pump, high level heat reclaim or dry cooler applications).	ALL
1280 **CONDENSER CONFIGURATION**			
1281 2 PASS CONDENSER	Inlet and outlet water connections on the same head	Inlet and outlet water connections on the same head	ALL
1283 4 PASS CONDENSER	Water realizes 4 tube side passes	Compatible with water with high delta temperature	ALL
1240 **CONDENSING PRESSURE CTRL DEV**			
1246 WITH MODULATING SIGNAL 0-10V	0-10 V signal on terminal board for the condensation control.	The 0-10V signal, it allows to manage several condensing devices in order to maintain the condensing pressure in a pre-defined range in every applications: - for well water application to manage a 2 way modulating valve; - for cooling tower application to manage a 3 way modulation valve; - for dry-cooler or cooling tower application to modulate the fans' speed; - for geothermal probe to modulate the pumps' speed.	ALL
1380 **3 WAY MODULATING VALVE**			
1384 3 WAY VALVE MOD. D	3 way modulating valve, steel made, with diverting function (see dedicated section).	It's recommended for applications with geothermal probes, in which the water flow is required to be constant.	ALL
1385 3 WAY VALVE MOD. E	3 way modulating valve, steel made, with diverting function (see dedicated section).	It's recommended for applications with geothermal probes, in which the water flow is required to be constant.	ALL
1386 3 WAY VALVE MOD. F	3 way modulating valve, steel made, with diverting function (see dedicated section).	It's recommended for applications with geothermal probes, in which the water flow is required to be constant.	ALL
1387 3 WAY VALVE MOD. G	3 way modulating valve, steel made, with diverting function (see dedicated section).	It's recommended for applications with geothermal probes, in which the water flow is required to be constant.	ALL
1800 **EVAPORATOR WATER FLOW SWITCH**			
1801 EVAPORATOR WATER FLOW SWITCH	Flow switch with stainless scoop AISI 316L and IP65 protection suitable for installation in industrial plant pipes. It should be installed in a straight pipe without filters, valves, etc., long at least 5 times its diameter, both upstream and downstream.	Signaling of lack of or excessive reduction of flow, it generates an alarm that is in automatic or manual reset depending on n ° alarms per hour and the maximum time of operation of the pump under conditions of low flow rate.	ALL
2630 **INSULATION ON EXCHANGERS**			
2631 DOUBLE INSULATION ON EXCHANGERS	Thermal insulation in closed-cell flexible elastomeric foam (FEF) of 16 mm coupled with a 3 mm layer of reticulated foam in PE and an exterior embossed finishing PE film. This option is mandatory if the unit is supposed to work with outdoor temperature below -10°C.	Reduces heat losses and prevent from condensate problems.	ALL
3020 **VPF CONTROL MANAGER FROM 3000**			
3021 VPF-VPF.D CONT. FROM SUPERVIS.	Variable pump flow control for units managed by group devices.		ALL

OPTIONS

OPTIONS	DESCRIPTIONS	BENEFITS	AVAILABLE FOR MODELS
2340 **UNIT ENCLOSURE**			
2316 COMPRESSORS SOUNDPROOFING	Compressors soundproofing covering	Reduction of 6 dB(A) on the total sound power	ALL
9960 **PACKING**			
9966 NYLON PACKING	Unit covered with nylon		ALL
9972 WOODEN BOX PACKING	Unit provided with wooden box		ALL
9973 WOODEN CAGE PACKING	Unit provided with wooden cage		ALL
9974 MARINE PACKING	Unit provided with barrier bag and wooden cage		ALL
9979 CONTAINER PACKING	Unit provided with container slides and covered with nylon		ALL

OPTIONS

Additional information - IMPORTANT -

- The option 3601 compressor operation signal is supplied as standard.

- The option 1801 evaporator flow switch is supplied loose.

- The options 1511 soft-starter and 3301 compressor power factor correction are to be applied only to the fixed speed compressor.

- The option 1246 condensing pressure control device with modulating signal 0-10V is supplied as standard.

- In case the option 4501 fast re-start is needed, it's necessary to ask the feasibility to our sales department. Restart times for units with this accessory selected depend on the unit size and the working conditions.

- For the proper functioning of the options C5110908, 3431 and 3432 we reccomend to install the unit in closed spaces.

- In order to facilitate the handling on site we suggest to select the option 9979. The unit without this accessory can only be uplifted.

- It's mandatory to attach the Elca technical selection to the order form.

- For the option 1901 compressor suction valve it's necessary to ask the feasibility to our sales department. The units supplied with this option could be higher than the standard ones and so could be not possible to deliver them inside a container.

SIZE	STANDARD HEIGHT	SUPPLEMENTARY HEIGHT WITH ACCESSORY 1901 SELECTED
	[mm]	[mm]
1402	SEE TABLE GENERAL TECHNICAL DATA	+ 115
1752		+ 225
1902		+ 30
2152		+ 25
2602		+ 20
3002		+ 70
3402		+ 70
3852		+ 70
4252		+ 70

OPTIONS

Chiller Plant Control with Active Optimization System

ClimaPRO System Manager

ClimaPRO System Manager represents the state-of-the-art platform for chiller plant management and control.
ClimaPRO ensures to actively optimize the entire chiller plant by managing and adjusting each component directly involved in the production and the distribution of the heating and the cooling energies, therefore involving chillers and heat pumps, pumping groups as well as the source-side devices like, for example, the cooling towers.

In particular, ClimaPRO measures in real-time all the operating variables from the field, for each individual device and each of the main system branche, by using serial communication lines as well as dedicated analogue signals.

The acquired data are then compared with the design data of each single unit at any different working conditions, thus allowing to implement control strategies based on dynamic algorithms which take into account the real operating conditions.

On the basis of these values, an advanced diagnostic module also allows to assess the level of efficiency for each individual unit, translating data into easy-to-read information in order to simplify and optimize the maintenance activities.

The “Chart Builder” software module allows to display the trends of the main operating variables. The “Reporting” module allows to send reports to selected users, including data and system’s status of the main devices as well as to perform calculation of the energy indexes for each single unit and for the entire chiller plant.

The accessibility to ClimaPRO System Manager is ensured by an integrated web server that makes it visible from any computer equipped with a web browser, either locally or remotely.

5.1 GENERAL TECHNICAL DATA i-FR-W (1+i)-G05-Z

[SI System]

i-FR-W (1+i)-G05-Z			1402	1752	1902	2152	2602	3002	3402	3852	4252
Power supply		V/ph/Hz	400/3/50	400/3/50	400/3/50	400/3/50	400/3/50	400/3/50	400/3/50	400/3/50	400/3/50
PERFORMANCE											
COOLING ONLY (GROSS VALUE)											
Cooling capacity	(1)	**kW**	**532,3**	**665,0**	**721,0**	**819,3**	**998,7**	**1143**	**1296**	**1472**	**1607**
Total power input	(1)	kW	102,0	124,6	135,4	154,6	189,4	216,0	243,1	275,6	303,9
EER	(1)	kW/kW	5,219	5,337	5,325	5,299	5,273	5,292	5,331	5,341	5,288
ESEER	(1)	kW/kW	8,360	8,410	8,310	8,450	8,440	8,380	8,400	8,430	8,280
COOLING ONLY (EN14511 VALUE)											
Cooling capacity	(1)(2)	**kW**	**530,7**	**662,9**	**718,8**	**816,9**	**995,5**	**1139**	**1293**	**1468**	**1602**
EER	(1)(2)	kW/kW	5,020	5,130	5,110	5,090	5,070	5,110	5,150	5,180	5,100
ESEER	(1)(2)	kW/kW	7,340	7,380	7,270	7,390	7,400	7,460	7,500	7,600	7,360
Cooling energy class			A	A	A	A	A	A	A	A	A
EXCHANGERS											
HEAT EXCHANGER USER SIDE IN REFRIGERATION											
Water flow	(1)	l/s	25,45	31,80	34,48	39,18	47,76	54,66	61,97	70,41	76,87
Pressure drop	(1)	kPa	36,3	41,3	40,2	39,4	44,0	44,5	37,8	36,6	43,7
HEAT EXCHANGER SOURCE SIDE IN REFRIGERATION											
Water flow	(1)	l/s	30,22	37,63	40,81	46,41	56,61	64,76	73,34	83,30	91,08
Pressure drop	(1)	kPa	45,3	42,9	50,5	50,2	46,9	36,4	40,4	36,0	43,0
REFRIGERANT CIRCUIT											
Compressors nr.		N°	2	2	2	2	2	2	2	2	2
Number of capacity steps		N°	0	0	0	0	0	0	0	0	0
No. Circuits		N°	1	1	1	1	1	1	1	1	1
Regulation			STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS	STEPSLESS
Min. capacity step		%	18	18	18	18	18	18	18	18	18
Refrigerant			R513A	R513A	R513A	R513A	R513A	R513A	R513A	R513A	R513A
Refrigerant charge		kg	130	176	181	195	284	325	347	356	372
Oil charge		kg	30,0	44,0	38,0	38,0	60,0	60,0	60,0	60,0	62,0
Rc (ASHRAE)	(3)	kg/kW	0,25	0,27	0,25	0,24	0,29	0,29	0,27	0,24	0,23
NOISE LEVEL											
Sound Pressure	(4)	dB(A)	82	82	81	83	83	83	82	82	84
Sound power level in cooling	(5)(6)	dB(A)	100	100	100	102	102	102	102	102	104
SIZE AND WEIGHT											
A	(7)	mm	2950	3310	3310	3310	4475	4475	4570	4650	4650
B	(7)	mm	1320	1425	1445	1480	1410	1405	1435	1495	1495
H	(7)	mm	1805	1935	2000	2150	2250	2250	2380	2500	2500
Operating weight	(7)	kg	3350	4280	4410	4830	6630	7470	8220	8800	8930

Notes:
1 Plant (side) cooling exchanger water (in/out) 12,00°C/7,00°C; Source (side) heat exchanger water (in/out) 30,00°C/35,00°C.
2 Values in compliance with EN14511
3 Rated in accordance with AHRI Standard 550/590 (2011 with addendum 1).
4 Average sound pressure level at 1m distance, unit in a free field on a reflective surface; non-binding value calculated from the sound power level.
5 Sound power on the basis of measurements made in compliance with ISO 9614.
6 Sound power level in cooling, indoors.
7 Unit in standard configuration/execution, without optional accessories.
- Not available
Certified data in EUROVENT

GENERAL TECHNICAL DATA

ENERGY EFFICIENCY

SEASONAL EFFICIENCY IN COOLING (Reg. EU 2016/2281)
Process refrigeration at high temperature

i-FR-W(1+i)-G05-Z			1402	1752	1902	2152	2602	3002	3402	3852	4252
Prated,c	(1)	kW	486,7	608,1	659,4	750,0	914,3	1046	1186	1348	1482
SEPR	(1)(2)		7,70	7,83	7,64	7,69	7,59	7,73	7,82	7,89	7,77

Notes:

(1) Seasonal energy efficiency of high temperature process cooling [REGULATION (EU) N. 2016/2281]
(2) Seasonal space heating energy index
The units highlighted in this publication contain R513A [GWP100 631] fluorinated greenhouse gases.

Certified data in EUROVENT

6.1 OPERATING LIMITS i-FR-W (1+i)-G05-Z 1402 - 4252

For the operating limits of each unit please refer to the ELCA WORLD technical selection.

6.2 ETHYLENE GLYCOL MIXTURE

Ethylene glycol and water mixture, used as a heat-conveying fluid, cause a variation in unit performance. For correct data, use the factors indicated in the following tabel.

	Freezing point (°C)							
	0	-5	-10	-15	-20	-25	-30	-35
	Ethylene glycol percentage by weight							
	0%	12%	20%	30%	35%	40%	45%	50%
cPf	1	0,985	0,98	0,974	0,97	0,965	0,964	0,96
cQ	1	1,02	1,04	1,075	1,11	1,14	1,17	1,2
cdp	1	1,07	1,11	1,18	1,22	1,24	1,27	1,3

cPf: cooling power correction factor
cQ: flow correction factor
cdp: pressure drop correction factor

For data concerning other kind of anti-freeze solutions (e,g, propylene glycol) please contact our Sale Department.

6.3 FOULING FACTORS

Performances are based on clean condition of tubes (fouling factor = 1). For different fouling values, performance should be adjusted using the correction factors shown in the following table.

SERIES	FOULING FACTORS	EVAPORATOR			CONDENSER/RECOVERY			DESUPERHEATER
	ff (m² °CW)	F1	FK1	KE [°C]	F2	FK2	KC [°C]	R3
VARIOUS	0	1,000	1,000	0,0	1,000	1,000	0,0	1,000
VARIOUS	$1{,}80 \times 10^{-5}$	1,000	1,000	0,0	1,000	1,000	0,0	1,000
VARIOUS	$4{,}40 \times 10^{-5}$	1,000	1,000	0,0	0,990	1,030	1,0	0,990
VARIOUS	$8{,}80 \times 10^{-5}$	0,960	0,990	0,7	0,980	1,040	1,5	0,980
VARIOUS	$13{,}20 \times 10^{-5}$	0,944	0,985	1,0	0,964	1,050	2,3	0,964
VARIOUS	$17{,}20 \times 10^{-5}$	0,930	0,980	1,5	0,950	1,060	3,0	0,950

ff: fouling factors
F1 - F2: potential correction factors
FK1 - FK2: compressor power input correction factors
R3: capacity correction factors
KE: minimum evaporator outlet temperature increase
KC: maximum condenser outlet temperature decrease

7.1 HYDRAULIC DATA

[SI System]

Water flow and pressure drop

Water flow in the plant (side) exchanger is given by:
Q=P/(4,186 x Dt)
Q: water flow (l/s)
Dt: difference between inlet and outlet water temp. (°C)
P: heat exchanger capacity (kW)

Pressure drop is given by:
Dp= K x (3,6 x Q)^2/1000
Q: water flow (l/s)
Dp: pressure drop (kPa)
K: unit size ratio

SIZE	Power supply V/ph/Hz	HEAT EXCHANGER USER SIDE					HEAT EXCHANGER SOURCE SIDE			
		K	Q min l/s	Q max l/s	C.A.S. l	C.a. min l	K [1]	Q min [2] l/s	Q max l/s	C.A.S. l
i-FR-W (1+i)-G05-Z /CA /1402	400/3/50	4,32	13,89	34,17	105	1860	3,83	14,72	35,00	115
i-FR-W (1+i)-G05-Z /CA /1752	400/3/50	3,15	16,67	38,89	115	2330	2,34	19,44	47,22	150
i-FR-W (1+i)-G05-Z /CA /1902	400/3/50	2,61	18,06	44,44	125	2520	2,34	19,44	47,22	150
i-FR-W (1+i)-G05-Z /CA /2152	400/3/50	1,98	20,83	50,00	145	2870	1,80	23,61	55,56	170
i-FR-W (1+i)-G05-Z /CA /2602	400/3/50	1,49	25,00	59,72	234	3460	1,13	26,39	62,50	260
i-FR-W (1+i)-G05-Z /CA /3002	400/3/50	1,15	27,78	68,06	260	4000	0,67	34,72	83,33	335
i-FR-W (1+i)-G05-Z /CA /3402	400/3/50	0,76	36,11	86,11	330	4540	0,58	37,50	90,28	360
i-FR-W (1+i)-G05-Z /CA /3852	400/3/50	0,57	40,28	97,22	370	5150	0,40	45,83	111,1	430
i-FR-W (1+i)-G05-Z /CA /4252	400/3/50	0,57	40,28	97,22	370	5630	0,40	45,83	111,1	430

The coefficient “K” on the source side heat exchanger is referred to its standart selection. When it’s required to move to an higher number of steps water side (with delta T >=10°C), “K” coefficient as to be multiplied for 8,5 (Knew = K x 8,5)

Q min: minimum water flow admitted to the heat exchanger

Q min [2]: minimum water flow admitted to the heat exchanger

Q max: maximum water flow admitted to the heat exchanger

C.a. min: minimum water content admitted in the plant

C.A.S.: Exchanger water content

8.1 ELECTRICAL DATA i-FR-W (1+i)-G05-Z

[SI System]

SIZE	Power supply V/ph/Hz	Maximum values						
		Compressor				Total (1)		
		n	F.L.I. [kW]	F.L.A. [A]	L.R.A. [A]	F.L.I. [kW]	F.L.A. [A]	S.A. [A]
1402	400/3/50	2	1x66+1x68	1x109+1x109	1x192+1xn.a.	134,0	218	249
1752	400/3/50	2	1x81+1x82	1x130+1x139	1x246+1xn.a.	163,0	269	318
1902	400/3/50	2	1x89+1x91	1x147+1x151	1x300+1xn.a.	180,0	298	381
2152	400/3/50	2	1x101+1x103	1x168+1x167	1x360+1xn.a.	204,0	335	451
2602	400/3/50	2	1x122+1x124	1x197+1x203	1x318+1xn.a.	246,0	400	422
3002	400/3/50	2	1x138+1x141	1x223+1x226	1x436+1xn.a.	279,0	449	551
3402	400/3/50	2	1x155+1x158	1x247+1x256	1x465+1xn.a.	313,0	503	591
3852	400/3/50	2	1x175+1x179	1x286+1x290	1x586+1xn.a.	354,0	576	732
4252	400/3/50	2	1x216+1x179	1x351+1x290	1x805+1xn.a.	395,0	641	951

F.L.I.: Full load power
F.L.A.: Full load current
L.R.A.: Locked rotor amperes for single compressor
S.A.: Inrush current

(1) Safety values to be considered when cabling the unit for power supply and line-protections

Data valid for standard units without any additional option.

Plant (side) cooling exchanger water (in/out) 12,00°C/7,00°C; Source (side) heat exchanger water (in/out) 30,00°C/35,00°C.

Voltage tolerance: 10%
Maximum voltage unbalance: 3%

Given the typical operating conditions of units designed for indoor installation, which can be associated (according to reference document IEC 60721) to the following classes:
- climatic conditions class AA4: air temperature range from 5 up to 42°C (*)
- special climatic conditions negligible
- presence of water class AD2: possibility of water dripping inside the technical room
- biological conditions class 4B1 and 4C2: negligible presence of corrosive and polluting substances
- mechanically active substances class 4S2: locations in areas with sand or dust sources

The required protection level for safe operation, according to reference document IEC 60529, is IP21 BW (protection against access of external devices with diameter larger than 12 mm and water falling vertically).
The unit can be considered IP21 CW protected, thus fulfilling the above operating conditions.

(*) for the unit's operating limits, see "selection limits" section

9.1 FULL LOAD SOUND LEVEL i-FR-W (1+i)-G05-Z

SOUND POWER LEVEL IN COOLING									
SIZE	Octave band [Hz]								Total sound level dB(A)
	63	125	250	500	1000	2000	4000	8000	
	Sound power level dB								
1402	83	88	91	97	98	86	75	70	**100**
1752	83	88	91	97	98	86	75	70	**100**
1902	83	88	91	97	98	86	75	70	**100**
2152	85	90	93	99	100	88	77	72	**102**
2602	85	90	93	99	100	88	77	72	**102**
3002	85	90	93	99	100	88	77	72	**102**
3402	85	90	93	99	100	88	77	72	**102**
3852	85	90	93	99	100	88	77	72	**102**
4252	87	92	95	101	102	90	79	74	**104**

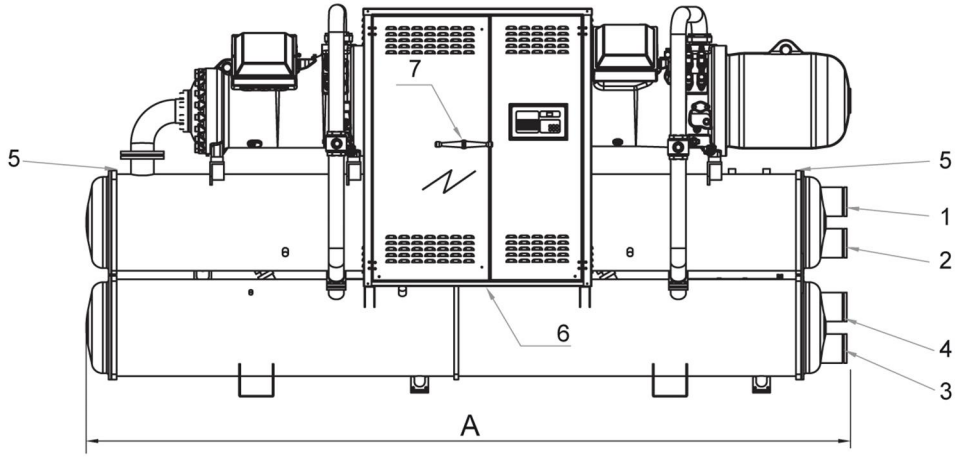
Working conditions

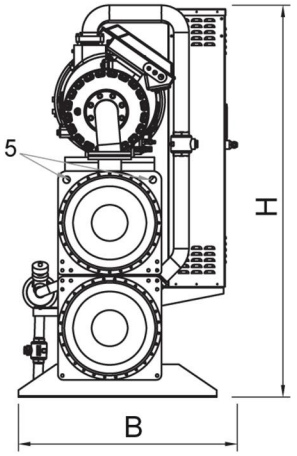
Plant (side) cooling exchanger water (in/out) 12,00°C/7,00°C; Source (side) heat exchanger water (in/out) 30,00°C/35,00°C.
Sound power on the basis of measurements made in compliance with ISO 9614.
Such certification refers specifically to the sound Power Level in dB(A). This is therefore the only acoustic data to be considered as binding.
Sound power level in cooling, indoors.

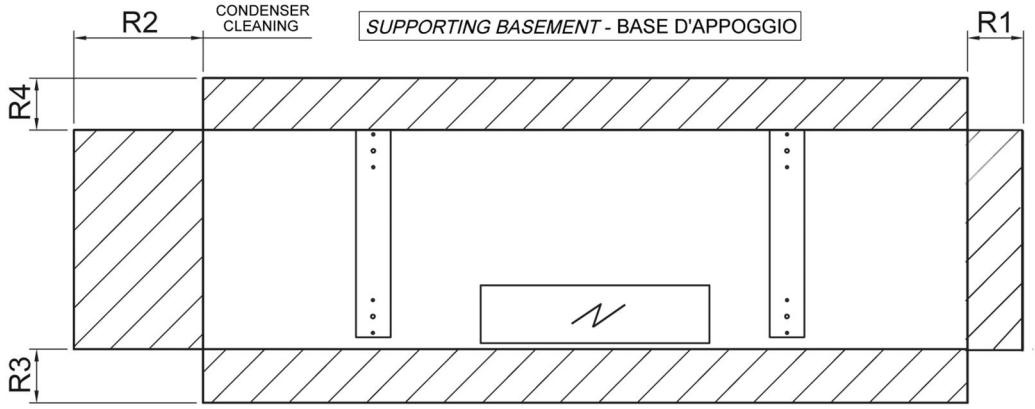
SOUND PRESSURE LEVEL									
SIZE	Octave band [Hz]								Total sound level dB(A)
	63	125	250	500	1000	2000	4000	8000	
	Sound pressure level dB								
1402	65	70	73	79	80	68	57	52	**82**
1752	65	70	73	79	80	68	57	52	**82**
1902	64	69	72	78	79	67	56	51	**81**
2152	66	71	74	80	81	69	58	53	**83**
2602	66	71	74	80	81	69	58	53	**83**
3002	66	71	74	80	81	69	58	53	**83**
3402	65	70	73	79	80	68	57	52	**82**
3852	65	70	73	79	80	68	57	52	**82**
4252	67	72	75	81	82	70	59	54	**84**

Working conditions

Plant (side) cooling exchanger water (in/out) 12,00°C/7,00°C; Source (side) heat exchanger water (in/out) 30,00°C/35,00°C.
Average sound pressure level at 1m distance, unit in a free field on a reflective surface; non-binding value calculated from the sound power level.







1 Evaporator water inlet
Entrata acqua evaporatore

2 Evaporator water outlet
Uscita acqua evaporatore

3 Condenser water inlet
Entrata acqua condensatore

4 Condenser water outlet
Uscita acqua condensatore

5 Lifting points
Punti di sollevamento

6 Power inlet
Ingresso linea elettrica

7 Main isolator
Sezionatore generale

REMARKS:For installation purposes, please refer to the documentation sent after the purchase-contract. This technical data should be considered as indicative. Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A. may modify them at any moment. Data valid for standard units without any additional option.

DIMENSIONAL DRAWINGS i-FR-W (1+i)-G05-Z 1402 - 4252

[SI System]

SIZE	DIMENSIONS AND WEIGHTS				CLEARANCE				HEAT EXCHANGER USER SIDE		HEAT EXCHANGER SOURCE SIDE	
	A	B	H	WEIGHT	R1	R2	R3	R4	IN/OUT		IN/OUT	
	[mm]	[mm]	[mm]	[kg]	[mm]	[mm]	[mm]	[mm]	TYPE	Ø	TYPE	Ø
i-FR-W (1+i)-G05-Z /CA /1402	2950	1320	1805	3350	1000	2500	900	500	FLEXIBLE JOINT	4"	FLEXIBLE JOINT	4"
i-FR-W (1+i)-G05-Z /CA /1752	3310	1425	1935	4280	1000	2500	900	500	FLEXIBLE JOINT	5"	FLEXIBLE JOINT	5"
i-FR-W (1+i)-G05-Z /CA /1902	3310	1445	2000	4410	1000	2500	900	500	FLEXIBLE JOINT	5"	FLEXIBLE JOINT	5"
i-FR-W (1+i)-G05-Z /CA /2152	3310	1480	2150	4830	1000	2500	900	500	FLEXIBLE JOINT	6"	FLEXIBLE JOINT	6"
i-FR-W (1+i)-G05-Z /CA /2602	4475	1410	2250	6630	1000	4000	900	500	FLEXIBLE JOINT	6"	FLEXIBLE JOINT	6"
i-FR-W (1+i)-G05-Z /CA /3002	4475	1405	2250	7470	1000	4000	900	500	FLEXIBLE JOINT	6"	FLEXIBLE JOINT	6"
i-FR-W (1+i)-G05-Z /CA /3402	4570	1435	2380	8220	1000	4000	900	500	FLEXIBLE JOINT	8"	FLEXIBLE JOINT	8"
i-FR-W (1+i)-G05-Z /CA /3852	4650	1495	2500	8800	1000	4000	900	500	FLEXIBLE JOINT	8"	FLEXIBLE JOINT	8"
i-FR-W (1+i)-G05-Z /CA /4252	4650	1495	2500	8930	1000	4000	900	500	FLEXIBLE JOINT	8"	FLEXIBLE JOINT	8"

VARIABLE FLOW CONTROL

Pump energy consumption significantly impacts plant running costs, but it can be considerably reduced thanks to the use of variable speed pumps (inverter driven pumps), capable of adjusting the water flow rate according to the actual plant thermal load.
Mitsubishi Electric Hydronics & Cooling Systems has developed the VPF control series (Variable Primary Flow), that provides different water flow regulation logics specifically devoted to various hydraulic plant solutions: only a primary circuit, primary and secondary circuits, single unit or multi-unit systems.
The VPF systems adjust the pump speeds on the basis of the plant's thermal load and optimize the unit's thermoregulation algorithm for variable flow operation, in a dynamic and simultaneous way. This ensures the highest energy savings, stable operation, and complete reliability.

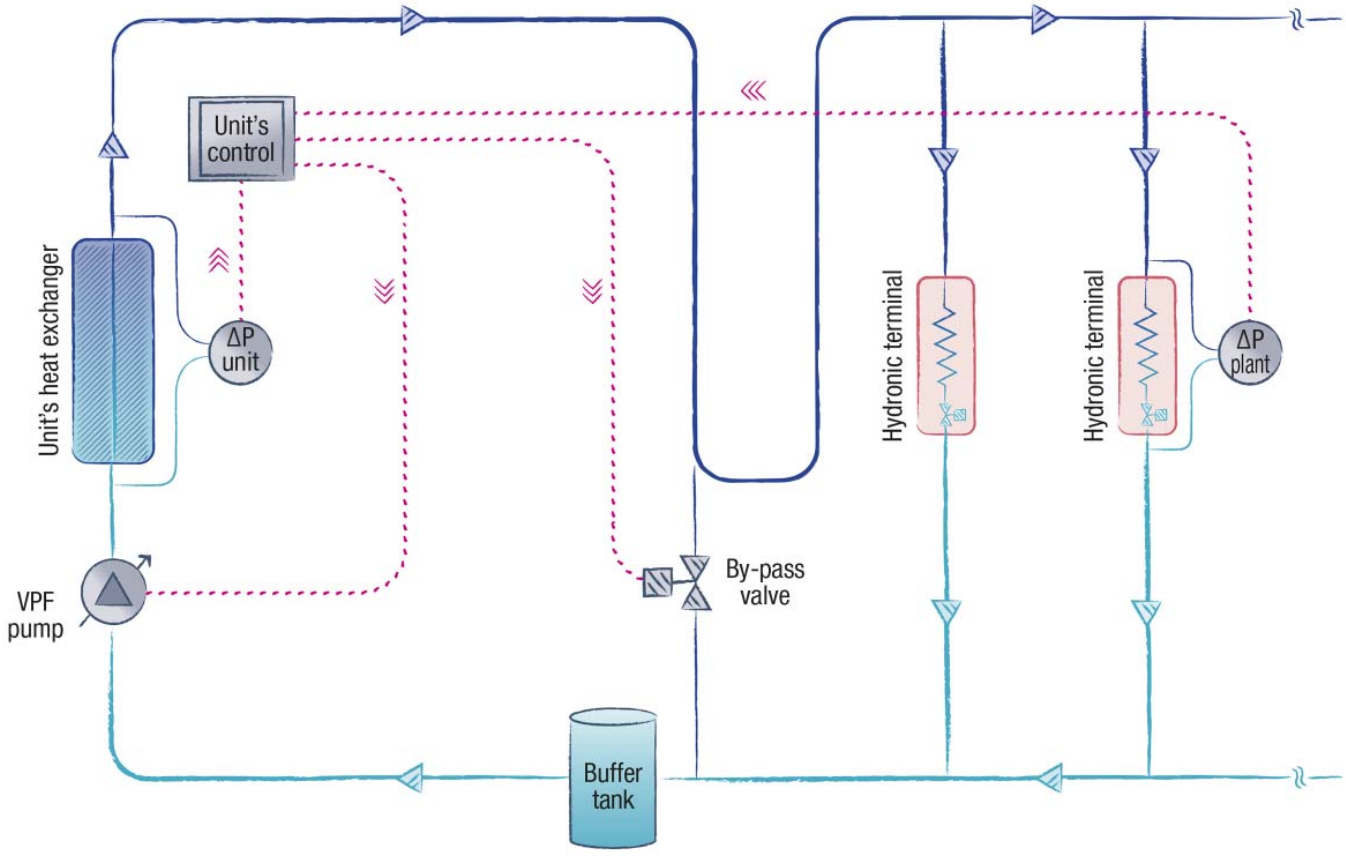
VPF SYSTEM (delta P control)
For plants with only a primary circuit

VPF - Plant and unit requirements

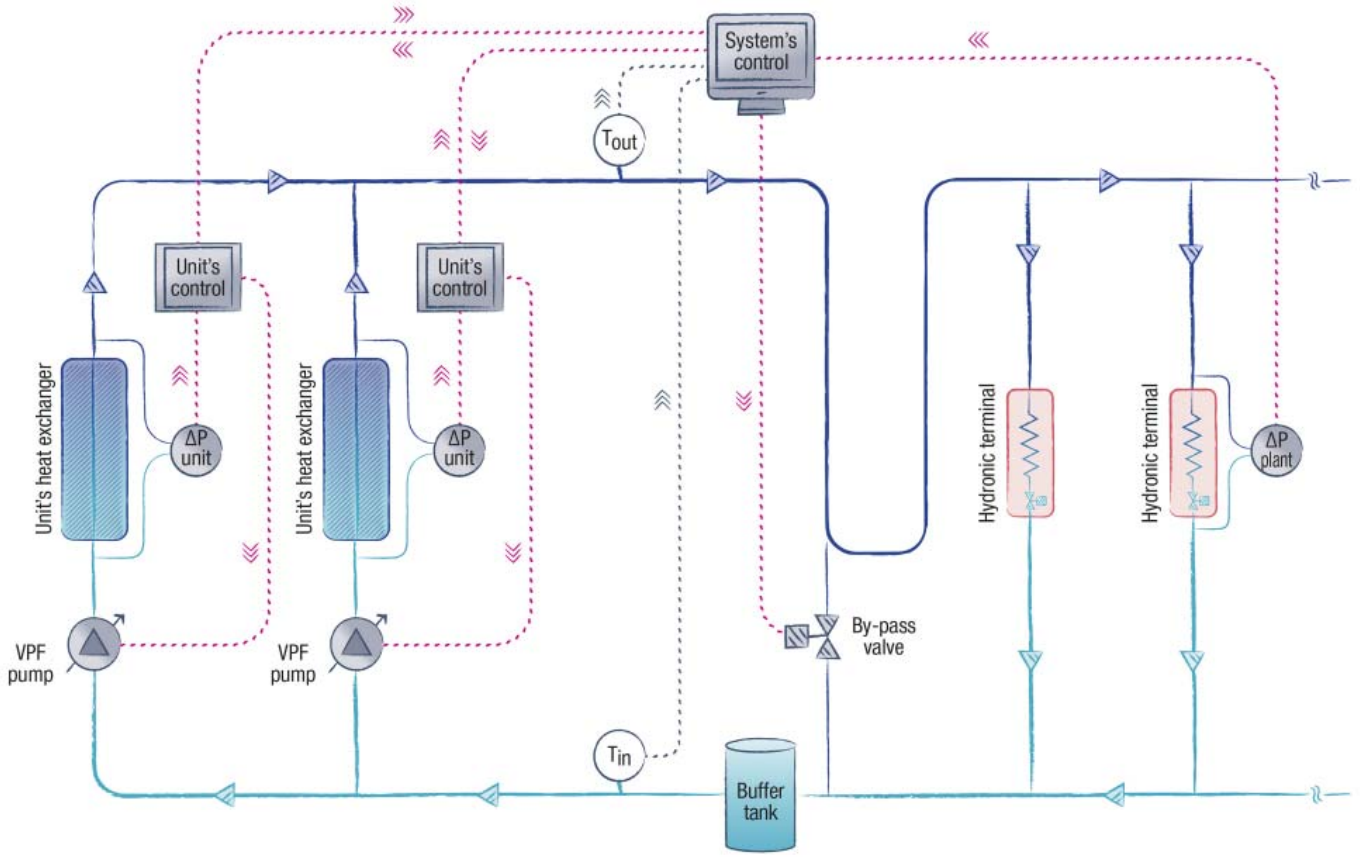
The VPF logic provides the variable flow control for the plant's primary circuit.

- Type of plant: primary circuit only, that feeds hydronic terminals fitted with a 2-way regulating valve
- Hydronic module: modulating regulation devices (0-10V signal) or variable speed pumps
- Unit thermoregulation: control of the leaving water temperature
- Monitored parameter: delta P on relevant users' hydronic terminal

Plant diagram for single unit system



Plant diagram for multi-unit system



VPF - Operating logic

Water flow regulation
The VPF system monitors the differential pressure on the plant side (ΔP) and adjusts the pump speed in order to keep it within a defined range (ΔPmin ↔ ΔPmax).

- If ΔPmin ≤ ΔP ≤ ΔPmax
  The plant water flow is appropriate to the thermal load, the pump speed is kept constant.

- If ΔP > ΔPmax
  The plant water flow exceeds what is necessary to properly cover the thermal load, the pump speed is reduced to save pump energy.

- If ΔP < ΔPmin
  The plant water flow is too low to ensure the proper feed to the hydronic terminals, the pump speed is increased.

With the VPF system, the water flow can be reduced to 50% of the unit nominal water flow, with regards to the selection conditions, provided that the minimum water flow required by the unit's heat exchanger is respected (the control of the heat exchanger's minimum water flow is described below).
The pump speed regulation is performed with little progressive adjustments while continuously monitoring the values of both the delta P on the plant side and the water temperature on the heat exchanger. The absence of abrupt water flow changes prevents fluctuation due to possible conflicts with the unit's thermoregulation function (compressor regulation).

Control of the unit's minimum water flow
Under no circumstances can the primary circuit water flow be reduced below the minimum water flow required by the unit's heat exchanger. The monitoring of the unit's water flow is performed through a factory installed differential pressure transducer on the unit's heat exchanger. If the differential pressure on the plant side requests a users' water flow lower than the unit's minimum water flow, the VPF system commands the gradual opening of the hydraulic by-pass valve (safety function). This ensures that the minimum water flow required by the unit's heat exchanger is always provided. As soon as the hydronic terminals request an increase of the water flow (ΔP < ΔPmin), the VPF closes the by-pass valve.

Multi-unit systems
The VPF control logic is also the same for multi-unit systems.
The plant side differential pressure transducer reading and the by-pass valve opening are managed by the multi-unit control system (Manager3000 or ClimaPRO).
Each unit autonomously adjusts its pump speed on the basis of the information provided by the multi-unit control system.
When the plant load requests the activation of a stand-by unit, the multi-unit control system calculates the starting speed of its pump in order to avoid excessive water flow variation of the running units.

VPF - Devices and installation

Device	Accessory name		
	VPF (plant DP trans excl)	VPF (plant DP trans incl)	VPF MULTI-UNIT SYSTEM
Differential pressure transducer on the unit's heat exchanger and related controller expansion board	Factory installed	Factory installed	Factory installed
Controller expansion board to read the plant side differential pressure transducer (4-20mA signal) and manage the hydraulic by-pass valve opening (0-10V signal)	Factory installed	Factory installed	Factory installed on the multi-unit control system (2)
Plant side differential pressure transducer	Not included (the supply is the customer's responsibility) (1)	Factory supplied, installation is the client's responsibility (1)(2)	Factory supplied with the multi-unit control system, installation is the client's responsibility (1)(3)
Plant side hydraulic by-pass valve	Not included (the supply is the customer's responsibility) (4)	Not included (the supply is the customer's responsibility) (4)	Not included (the supply is the customer's responsibility) (4)

(1) It is recommended to install the differential pressure transducer on the most hydraulically critical hydronic terminal, to ensure it has a proper water flow in any load condition.
(2) Technical features of the differential pressure transducer supplied:
Model: Huba Control 692.9 120071C1
Pressure range: 0 ... + 1 bar
Output: 4-20mA
Electrical connection: DIN EN 175301-803-A (IP 65)
Pressure connection adapters: male threaded G 1/8"
(3) It is the customer's responsibility to configure the multi-unit control system (Manager3000 or ClimaPRO) with option VPF.
(4) See attached table for information on the hydraulic by-pass design.

The following table provides the indications for a correct hydraulic by-pass design.

Heat exchanger minimum flow (m^3/h) (1)	Minimum by-pass diameter	Minimum by-pass valve diameter	Suggested valve model	Kvs	Suggested actuator model
From 19 to 30	DN50 (2")	DN50 (2")	VVG41.50	40	SKB60
Up to 37	DN65 (2" ½)	DN65 (2" ½)	VVF31.65	49	SKB60
Up to 60	DN80 (3")	DN80 (3")	VVF31.80	78	SKB60
Up to 95	DN100 (4")	DN100 (4")	VVF31.90	124	SKC60
Up to 150	DN125 (5")	DN125 (5")	VVF31.91	200	SKC60
Up to 230	DN150 (6")	DN150 (6")	VVF31.92	300	SKC60

(1) In case of a multi-unit system, the unit with the highest minimum water flow should be the reference.

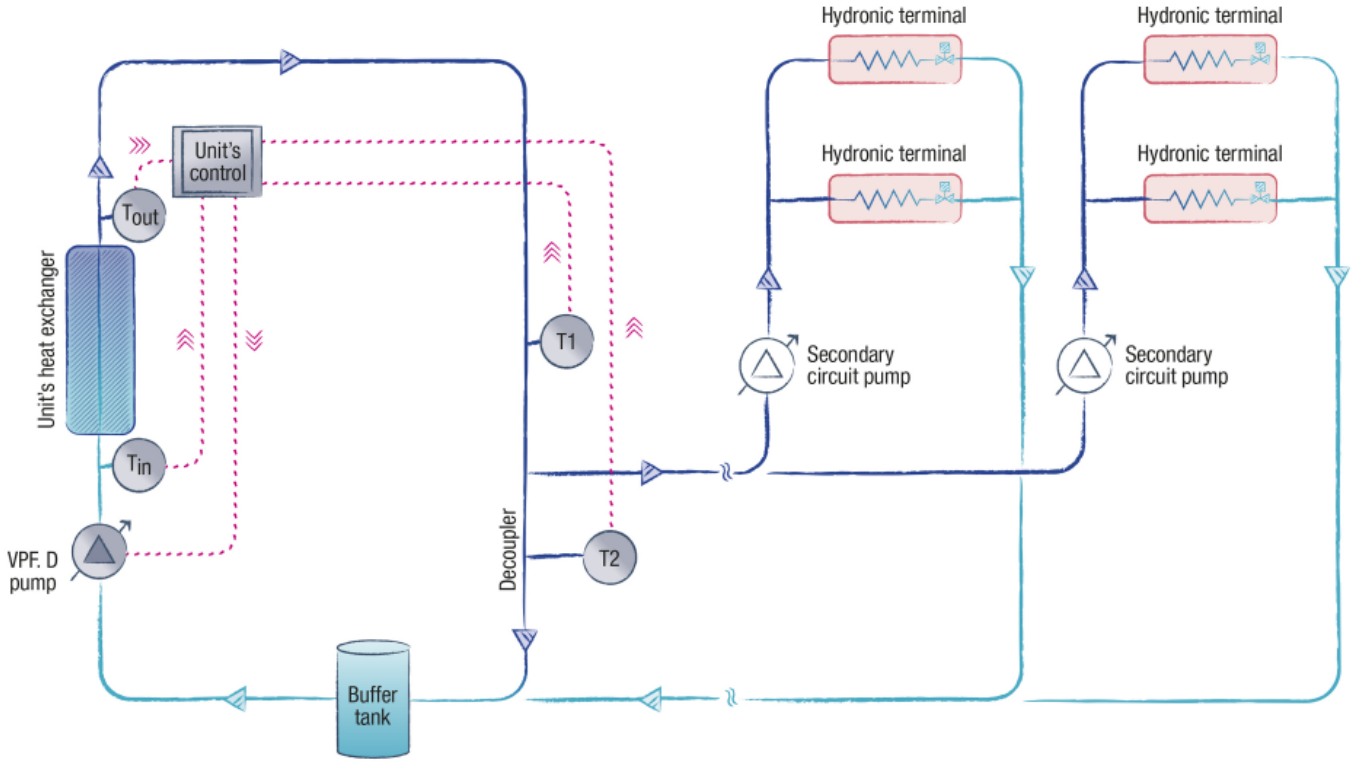
VPF.D SYSTEM (delta T control)
For plants with primary and secondary circuits separated by a hydraulic decoupler.

VPF.D - Plant and unit requirements

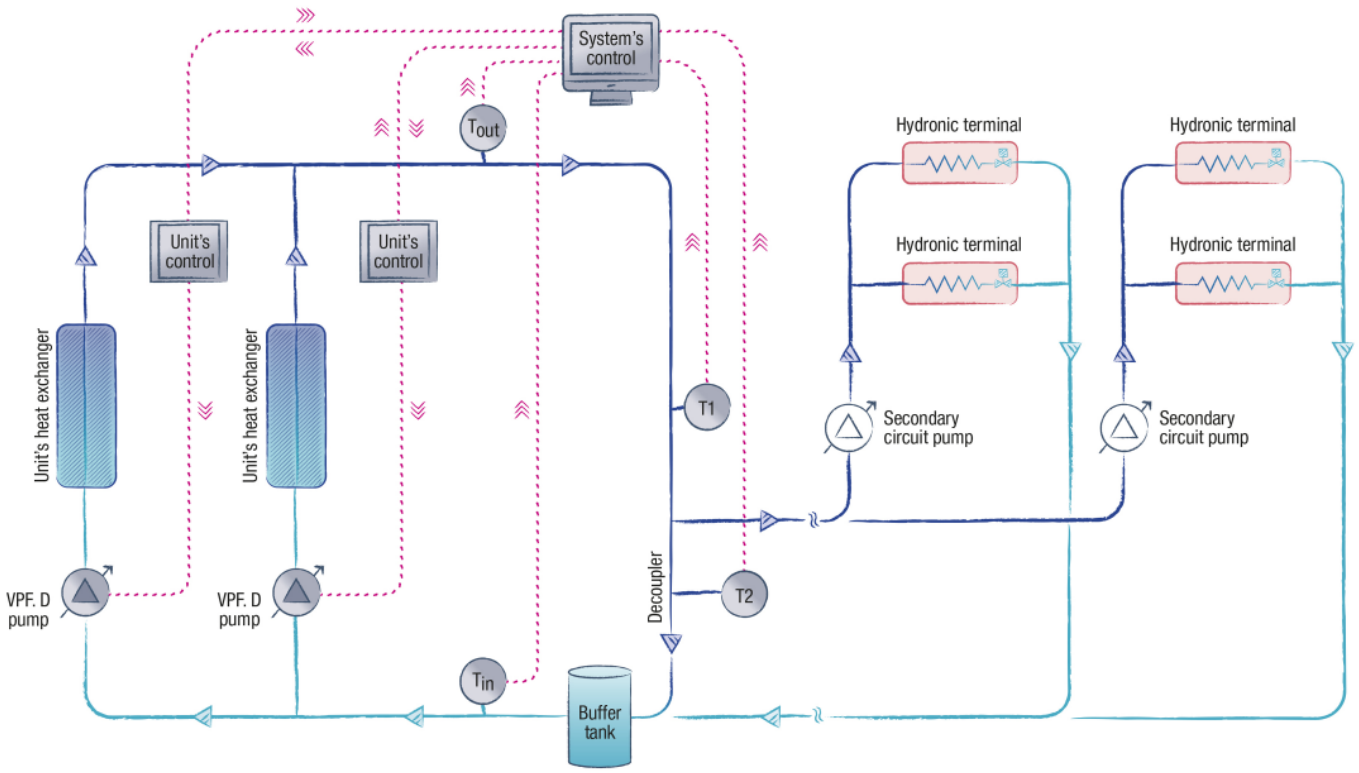
The VPF.D logic provides the variable flow control for the plant's primary circuit.

- Type of plant: primary and secondary circuits separated by a hydraulic decoupler
- Hydronic module: modulating regulation devices (0-10V signal) or variable speed pumps
- Unit thermoregulation: control of the leaving water temperature
- Monitored parameter: delta T on primary circuit

Plant diagram for single unit system



Plant diagram for multi-unit system



VPF.D - Operating logic

Water flow regulation
The VPF.D system monitors the temperature difference of the primary circuit (ΔT) (that corresponds to the temperature difference of the unit's heat exchanger in the case of a single unit system), and adjusts the primary circuit's pump speed in order to keep it within a defined range (ΔTmin ↔ ΔTmax). The secondary circuit water flow is completely independent and is to be managed by the client.

- If ΔTmin ≤ ΔT ≤ ΔTmax
  The plant water flow is appropriate to the thermal load, the pump speed is kept constant.

- If ΔT < ΔTmax
  The plant water flow exceeds what is necessary to properly cover the thermal load, the pump speed is reduced to save pump energy.

- If ΔT > ΔTmin
  The plant water flow is too low to ensure the proper feed to the users, the pump speed is increased.

To prevent the returning water of the secondary circuit from recirculating through the decoupler and mixing with the delivery water, which would cause serious plant regulation problems, the VPF.D provides a safety function based on the temperatures, which are detected by two probes on the plant side: T1 on the unit delivery line and T2 on the hydraulic decoupler. If during the water flow regulation of the circuits, the flow direction in the decoupler reverses (detected temperatures T1 < T2), the system forces a quick increase of the primary water flow until the correct direction of the flow in the decoupler is restored (detected temperatures T1 = T2).

With the VPF.D system, the water flow can be reduced to 50% of the unit nominal water flow, with regards to the selection conditions, provided that the minimum water flow required by the unit's heat exchanger is respected (the control of the heat exchanger's minimum water flow is described below).
The pump speed regulation is performed with little progressive adjustments while continuously monitoring the values of both the temperature difference on the primary circuit and the temperatures of the probes T1 and T2. The absence of abrupt water flow changes prevents fluctuation due to possible conflicts with the unit's thermoregulation function (compressor regulation).

Control of the unit's minimum water flow
Under no circumstances can the primary circuit water flow be reduced below the minimum water flow required by the unit's heat exchanger. The unit's minimum water flow is ensured by setting the minimum pump speed (service menu parameter).

Multi-unit systems
The VPF.D control logic is also the same for multi-unit systems.
The reading of the temperature difference on the primary circuit and the reading of the temperature probes T1 and T2 is managed by the multi-unit control system (Manager3000 or ClimaPRO).
Each unit autonomously adjusts its pump speed on the basis of the information provided by the multi-unit control system.
When the plant load requests the activation of a stand-by unit, the multi-unit control system calculates the starting speed of its pump in order to avoid excessive water flow variation of the running units.

VPF.D - Devices and installation

Device	Accessory name	
	VPF.D	VPF.D MULTI-UNIT SYSTEM
2 plant side NTC temperature sensors and related controller expansion board	Factory supplied (probes supplied without wells), installation is the client's responsibility (1)	Factory supplied with the multi-unit control system (probes supplied without wells), installation is the client's responsibility (1)(2)

(1) It is recommended to install the temperature probes as shown in the enclosed plant diagrams (T1 on the unit delivery line, T2 on the hydraulic decoupler)
(2) It is the customer's responsibility to configure the multi-unit control system (Manager3000 or ClimaPRO) with option VPF.D.

The following table provides the indications for a correct hydraulic decoupler design.

Heat exchanger minimum flow (m^3/h) (1)	Minimum hydraulic decoupler diameter
From 25 to 40	DN65 (2" ½)
Up to 60	DN80 (3“)
Up to 100	DN100 (4“)
Up to 150	DN125 (5“)
Up to 225	DN150 (6”)
Up to 375	DN200 (8”)

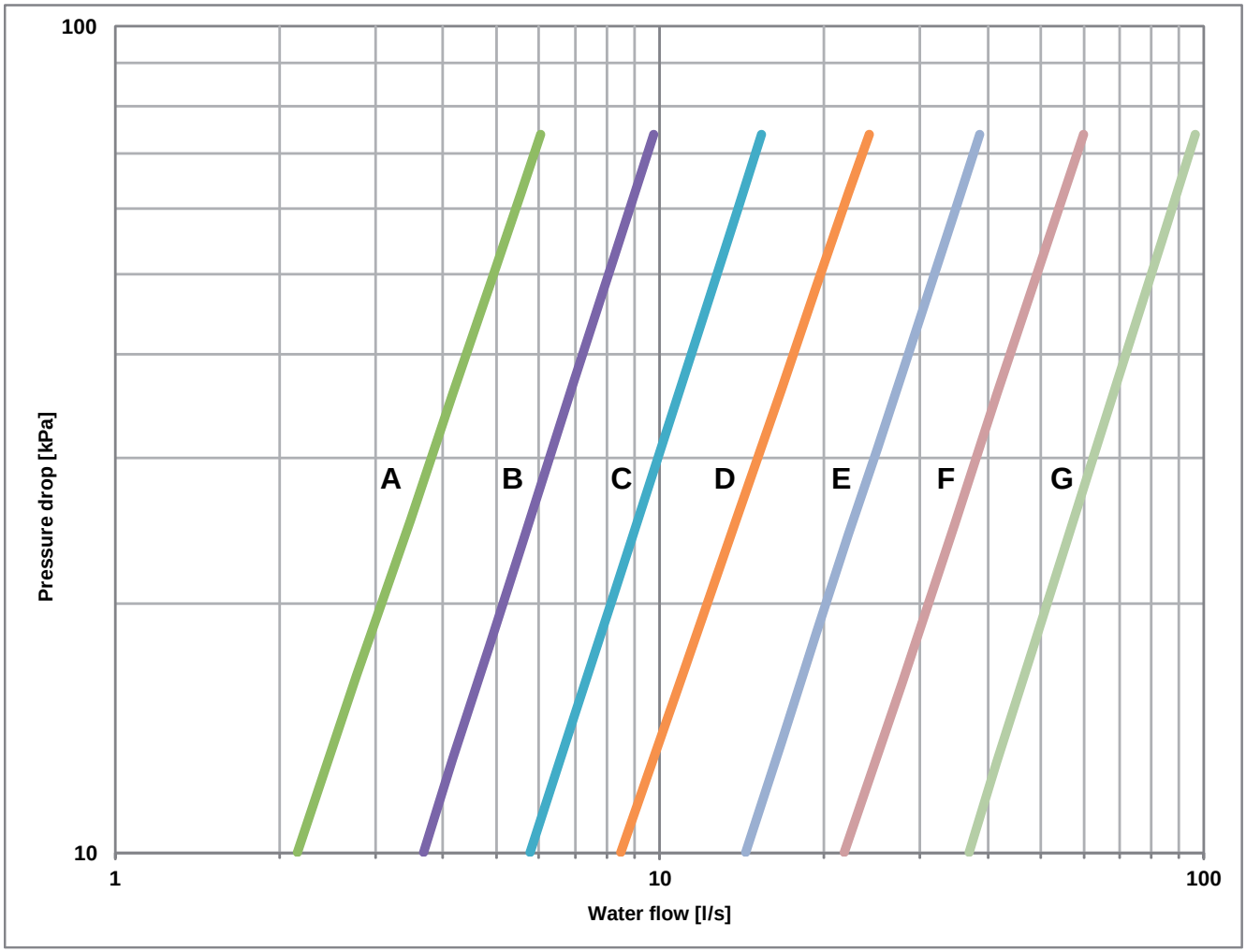
(2) In case of a multi-unit system, the unit with the highest minimum water flow should be the reference.

3 Way valve

3 way modulating valve, steel made, with diverting function.

The choice of the valve models has been made in order to optimize the pressure drops as function of the condenser water flow.

Model valve	Qmin	Qmax
	[l/s]	[l/s]
A	3,3	5
B	5	7,8
C	7,8	12,5
D	12,5	20
E	20	31
F	31	50
G	50	79



The harmonic distortion due to power frequency conversion
The increasing need for chillers to work with high efficiency at part loads has led to the introduction of the frequency converter (commonly called inverter) in order to drive the compressor.
The frequency converter varies the compressor's rotation speed through the regeneration of the power voltage, keeping its amplitude and frequency under control, through a conversion of the electrical power in two steps: first with a AC→DC rectifier and then with a inverter DC→AC inverter.
The use of the frequency converter determines an AC current characterized by a non-sine periodic wave form with given frequency f. This wave can be broken out into a sine wave called pure wave and a certain number of waves with greater frequencies (multiples of f), called harmonic waves and numbered with rising odd numbers (3°, 5°, 7°,…).

Power Factor, Displacement Power Factor and Total Harmonic Distortion
The harmonic waves do not contribute to the absorption of active power from the power source, but their presence causes:
- The presence of voltage harmonics that worsen the quality of the grid power voltage thus leading to possible malfunctions of the loads connected to this power grid.
- The worsening of the unit power factor PF, resulting in higher charges for the client from the electricity distribution company.

The Power Factor PF of a system is equal to the ratio between the active power and the apparent power and it is formulated in the following way:

$$PF = \frac{1}{\sqrt{1+THD_i^2}} DPF$$

DPF (Displacement Power Factor) is equal to the cosf of the pure current wave.
THD (Total Harmonic Distorsion) is the rate which describes the amount of the harmonic distortion. In particular THDi refers to the current wave and THDv to the voltage wave.

It is therefore clear that, whenever harmonics are present, the Power Factor PF is different from the Displacement Power Factor, and that the heavier the harmonics are, the greater the difference is.

In general, frequency converters are characterized by an intrinsic constant DPF (Displacement Power Factor) value between 0.97 and 0.99, while the Power Factor PF varies according to the load conditions, usually becoming worse when load partialization increases.

The following table displays the values of Power Factor PF and current Total Harmonic Distortion for the units of the family i-FX-W (1+i):

Size	MAXIMUM		100%		75%		50%		25%	
	P.F.	THDi [%]	P.F.	THDi [%]	P.F.	THDi [%]	P.F.	THDi [%]	P.F.	THDi [%]
1402	0.9	21	0.9	28	0.8	24	0.8	84	0.7	104
1752	0.9	27	0.9	36	0.9	25	0.7	94	0.7	110
1902	0.9	24	0.9	33	0.8	25	0.7	89	0.7	107
2152	0.9	21	0.9	29	0.8	24	0.7	84	0.7	104
2602	0.9	22	0.9	31	0.9	24	0.7	87	0.7	106
3002	0.9	20	0.9	28	0.9	24	0.8	83	0.7	104
3402	0.9	21	0.9	28	0.9	24	0.7	84	0.7	105
3852	0.9	21	0.9	29	0.9	24	0.8	83	0.7	104
4252	0.9	19	0.9	25	0.8	20	0.8	72	0.7	103

Values valid at the following conditions:
- Maximum water production temperatures 20/15°C – 45.5/50.5°C
- Condition of 100% load at 12/7°C – 30/35°C
- Condition of 75% load at _/7°C - 26°C/_
- Condition of 50% load at _/7°C - 22°C/_
- Condition of 25% load at _/7°C - 18°C/_

The objective and unquestionable THDi measurement of a device can only be taken when the device is working in a power grid with some specific characteristics as described in the reference standards (e.g.: CEI EN 61000-3-12). Where the measurement of the THDi value is performed without a standardized power voltage, the resulting values are influenced by the THDv value of the power grid.

Available options:
Option 3301: Compressors power factor correction
This accessory allows to bring the compressors' power factor to values as near as possible to the ones of an ideal power grid (value characteristic of an ideal power grid=1), until a maximum of 0.95.
The presence of this accessory does not modify the frequency converter's intrinsic Displacement Power Factor DPF value (which remains between 0.97 and 0.99).

MITSUBISHI ELECTRIC HYDRONICS & IT COOLING SYSTEMS S.p.A.

Head Office: Via Roma 5 • 27010 Valle Salimbene (PV) • Italy
Ph. (+39) (0) 382 433 811 • Fax (+39) (0) 382 587148
www.rcitcooling.com
www.melcohit.com