Introduction to the FRIGOLINK system

(Status as of 2015-05)

Contents

1 The FRIGOLINK system

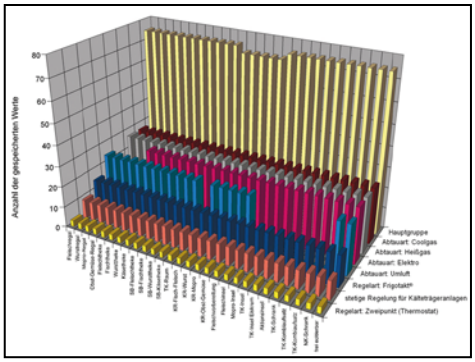
The FRIGOLINK control system is presented in the introduction.The focus here is on the system's components, structure and control concepts.
You can look up all further information in the detailed FRIGOLINK manual.
You can obtain it from your Wurm sales partner.

1.1 The concept

FRIGOLINK offers comprehensive control solutions for industry and supermarket refrigeration as well as for building technology. It can be built up simply and quickly and is easily set up and simple to operate.
The FRIGOLINK control system primarily recognises two system components: master modules and field modules.
The master module is built into the switch cabinet and takes over central control and coordination of the field modules. It also serves as central operating unit.
The field modules, in contrast, can be placed in electrical distribution cabinets or furniture strips and are used for recording measurement values and for input and output switching signals.

1.2 The expert database

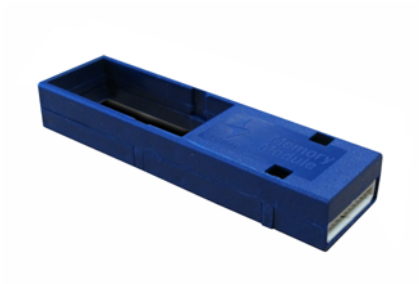
Standard settings for all applications are stored in the master module in the expert database. This expert database encompasses a multitude of parameters, which are laid out differently depending on the application.
The foundation for the expert database is many years of evaluating measurement data. They show that, for almost all plant types and makes, a standard setting can be found under which the plant works optimally.
Fine-tuning of the systems is then often limited to just a few parameters.



The Expert Database

1.3 The Memory Module

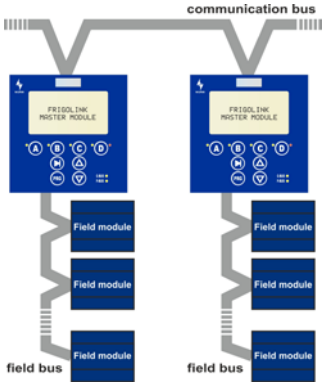
All parameter settings for the system (setpoints, individual user texts for controller, inputs and outputs) are stored in the memory module.
It is designed as a plug-in module and can be easily exchanged at any time.
This has enormous advantages for system configuration, as it can be performed in advance on the computer. If such a pre-parameterised memory module is used, all entered parameters and texts are available immediately.



The Memory Module

1.4 System communication

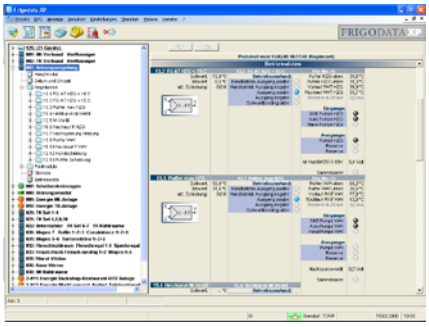
In system communication, FRIGOLINK relies on the CAN bus, which has proved itself millions of times in automation technology.
Data exchange between master and field modules takes place via the field bus. For system communication with the gateway and between the master modules, a second CAN bus interface is available:
Fault messages and central control and measurement signals are exchanged via the communication bus.
Both bus systems are galvanically isolated from one another. This increases reliability considerably.



The FRIGOLINK bus system

1.5 Remote Data Transmission with FRIGODATA XP

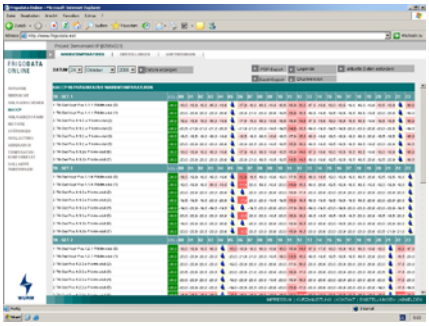
In the interplay with gateways and the FRIGODATA XP software, the FRIGOLINK system can be completely remote controlled and monitored.
Besides receiving fault messages from the plant, you can adjust setpoints, call up log data or observe the plant remotely.



FRIGODATA XP

1.6 FRIGODATA ONLINE

FRIGODATA ONLINE permits observation of your system via the Internet without special software.
You only need a computer with Internet access, an Internet browser and enabling via your sales partner.



FRIGODATA ONLINE

FRIGOLINK master modules with switch cards

FRIGOLINK field modules

Lid print on the field modules

Cold location field module FKD003

2 The components

2.1 Master modules

The master module is built into the switch cabinet and takes over regulation as well as central control and coordination of the field modules, and is also used as a central display and control unit.

Various master module types – adapted to the respective application – are available. The devices continue to be available in different language variants.

All operating elements are located on the front of the master module. They include the four-line display with plain text, eight keys for operation, six LEDs for menu and master module status, an LED for the fault message, and a Western socket for connecting a laptop (via CAN-PC converter).

2.2 Field modules

The field modules serve to record measurement values (temperature, pressure, etc.) as well as to input and output switching signals and are placed in electrical distribution cabinets or furniture strips.

Various field modules are available for the analysis and monitoring of cold locations, compressors, fans, pumps, electronic expansion valves (EEV), etc. The field modules may be installed in the central switch cabinet, the subdistributor or in the base of a refrigerator.

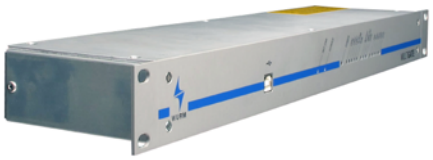
The field modules have a large number of analogue and digital inputs and outputs.
Each input or output is assigned to a specific function. These functions and their wiring are printed on the cover.

If the system communication malfunctions, the field modules ensure limited operation via emergency programs.

Besides the master and field modules, there are a multitude of additional components that complete the FRIGOLINK system:

2.3 Gateways

There are various gateways with different performance characteristics to fit system size and application. These can be equipped with various modems (analogue, ISDN) or with coupling via Ethernet (LAN).



Gateway Multigate

2.4 Switch cards

The system can be equipped with switch cards for switching function and status displays. These clearly show the operating and fault status of cold location and drives and make manual switching of individual consumers (e.g. compressors, fans or cold locations) possible.

2.5 Remote displays

Through the remote displays, the product temperature and cold location status can be displayed on the refrigeration unit front or in a separate cold room switchbox outside the control or machine room.

Remote display DSP002

2.6 Sensors

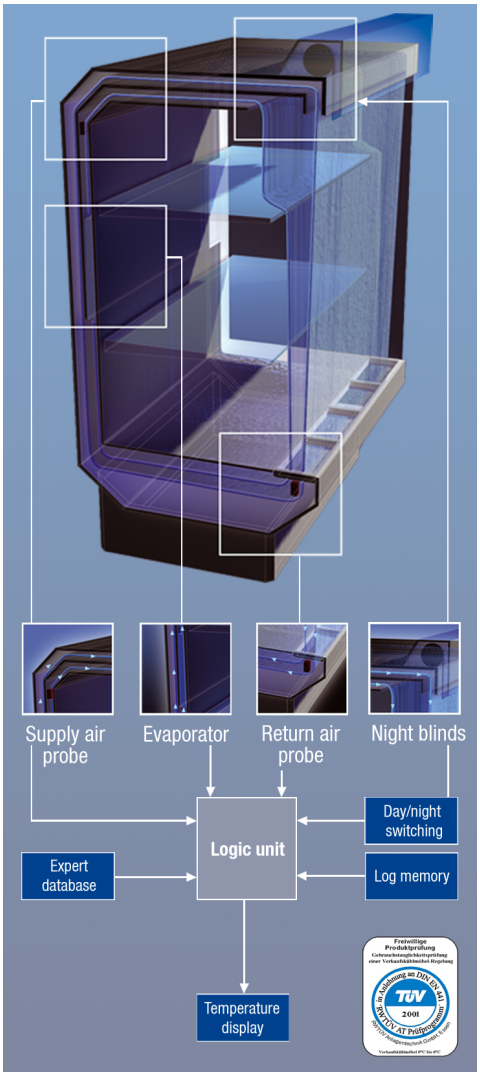
Various sensors are available for the different application areas of the system equipment.
Precision NTC sensors are available for temperature measurement.
Pressure transmitters serve to record low and high pressure. Additional sensors serve to record the air humidity in sales and cold rooms.

2.7 Driver modules

Various driver modules are available for controlling valves without internal amplifiers (e.g. EEVs or thermal valve drives).

2.8 Accessories

The FRIGOLINK range is rounded out with accessories such as module racks, power-level modules (for multiple switching of measurement signals), temperature and signal recording devices and a central display panel.
As a result, information can be taken over into FRIGOLINK from other systems or existing plants.



Determining the representative wares temperature

3 Cold location control

3.1 Control process for cold locations

The cold location master module HKS-G3 controls and monitors up to 8 cold locations or evaporators.
This covers all applications, from simple thermostat function up to constant control, with brine or expansion valves. The required parameters are stored in the expert database and can be called down when the cold location is set up.

FRIGOLINK controls the cold locations according to the representative goods temperature (TÜV-certified according to EN441) and helps you fulfil the requirements of the hygiene ordinance HACCP.

With intelligent additional functions, such as defrost on demand, latent heat use and Frigotakt+ control processes, you protect the products and achieve considerable energy and cost savings.
Special defrost functions, such as successor and group defrosting or forced cooling (necessary for hot and cool gas defrosting), ensure an optimised, higher-level defrost coordination beyond cold locations and master modules.

Central switching functions, such as the day/night signal or emergency switch-off in case of compound malfunction, can be achieved through the communication bus.

3.2 Thermostat control

A two-point controller is depicted in the thermostat control. When the actual value exceeds or falls below the setpoint by half the switching difference, the cooling output is switched on or off. The thermostat control can be combined with a superheating control (EEV).

3.3 Frigotakt+

Frigotakt+ is a control process developed by Wurm GmbH. This process permits performance-dependent compressor switching, since here FRIGOLINK recognises the required cooling output of the cold locations in the compound. The Frigotakt+ control can be combined with a superheating control (EEV).

3.4 PID control

The PID control is used to trigger constant actuators. A constant correcting variable, which is available at the analogue output of the field module as voltage 0...10V for triggering valves, is determined from the control difference between setpoint and product temperature.
The PID control can be combined with an overheating control (EEV).

3.5 3-point

A three-zone thermostat with the areas cooling, heating and neutral zone is imitated for temperature control. The 3-point temperature control can also be combined with an "Rh" humidity control or EEV control.

3.6 Constant/AT1B

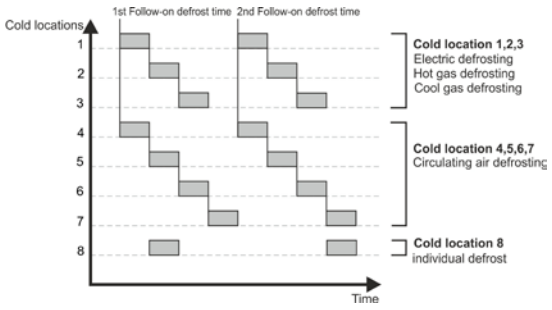
FRIGOLINK offers the control process Constant/AT1B for use in refrigerant equipment with Siemens AT1B actuators. In this control process, the actuator is triggered via a specially modulated PWM signal.

3.7 Overheating control (EEV)

The EEV control can be optionally activated for every cold location. The valve can be triggered constantly or through a PWM signal.
For the control process, you can select between superheating control (combined with thermostat function) or constant control.
With constant control, the EEV remains permanently opened; the evaporator performance, and thus the temperature, is constantly controlled via the degree of opening.
Special safety functions for the use of refrigerant R744 (CO_2) are integrated.

3.8 Defrosting

You can choose between the forced air, electric, hot or cool gas defrosting processes. FRIGOLINK permits realisation of complex defrosting plans via the channel and follow-on defrosting.



Defrosting scheme

3.9 Overview of the functions of HKS-G3

Control process

- Thermostat
- Frigotakt+
- PID
- Constant/AT1B
- 3-point

Defrosting

Defrosting
- EC defrosting
- Recording of defrost duration and melting time per evaporator
- Regulated defrost heater for industry cold rooms

Defrosting process
- Forced air defrosting
- Electrical defrosting
- Hot gas defrosting
- Cool gas defrosting

Defrost start
- Individual defrost
- Follow-on defrosting
- Channel defrosting
- Manual defrosting

Defrost module FIO001B or FIO-PAT
- Forced cooling for cold locations
- Forced shutdown of cold locations
- Signal of “defrosting active”
- External initiation of follow-on defrosting

Alarm

- Overtemperature and undertemperature warning
- Monitoring of defrost safety time (optional fault or operating message)
- Monitoring of door contact switch (optional fault or operating message)
- High and low humidity warning

Special functions

for refrigeration units
- Monitoring of modular refrigerators by alarm sensors
- Continuous operation monitoring
- Deep-freeze double island with medium evaporator

for cold rooms
- Digital input "Cold room door open"
- Regulating actual value copy
- Regulated defrost heater for industry cold rooms

Fault list/operating list

- Fault list (50 entries)
- Operating list (25 entries)

Higher-level bus communication

- Total failure of compressor rack
- Day/ night signal
- Clock synchronisation
- Temperature and relative humidity in sales room

Other

- Automatic summer/winter time changeover
- Operating hours counter for cooling, defrosting and fan switch outputs
- Adjustable sensor balancing for temperature sensors, pressure transmitters and humidity sensors
- Alarm outputs (Prio 1 + 2)
- Two separate internal log storage locations with variable time grid (FRIGOPLOT/DOKUPLOT) and average value calculation (DOKUPLOT)

3.10 Overview of cold locations field modules

Field module type	FKR002B	FKV003	FKL003	FKD003	FKE003
Mechanical characteristics					
Installation on DIN profile rails	X	X	X	-	-
Installation in refrigerator front	-	-	-	X	X
Voltage supply with 230V~	X	X	X	-	-
Voltage supply with external transformer TR9-9-4	-	-	-	X	X
Field bus service socket for laptop	-	-	-	X	X
Connection via pre-made lines	-	X	X	X	X
Integrated display	-	-	-	X	X
Remote display via DSP002 (Connection via pre-made plug-and-socket connection)	-	X	X	-	-
Inputs/outputs					
Sensor inputs					
Supply air temperature	X	X	X	X	X
Return air temperature	X	X	X	X	X
Defrost limit temperature	X	X	X	X	X
Suction gas temperature	-	X	X	X	X
Analogue input 4…20mA for pressure sensor p_0 or moisture sensor Rh	-	X	X	X	X
Digital inputs for cold location off, 2nd setpoint and cold room door open	X	X	X	X	X
Digital outputs					
Cooling (relay)	X	X	-	X	X
Defrost (relay)	X	X	X	X	X
Fan (relay)	X	X	X	X	X
Cooling or PWM for EEV (via semiconductor relay 230V~, with internal feed)	-	-	X	-	-
Analogue outputs	1	2	2	1	1
0…10V=, for constant controls	X	X	X	-	-
PWM (pulse-width modulated) for EEV- via ATV230	-	X	X	X	X
Control process and operating modes					
Thermostat …	X	X	X	X	X
Frigotakt+ …	X	X	X	X	X
PID …	X	X	X (3)	-	-
Constant AT1B …	X	X	X	X	X
3-point	X	X	X	X	X
Thermostat with EEV	-	X	X	X (1)	X
Frigotakt+ with EEV	-	X	X	X (1)	X
PID with EEV	-	X	X	X (1)	X
3-point with EEV	-	X	X (2)	X (1)	X
3-point with Rh (3-point / constant / only Rh control)	-	X/X/X	X/X/X	X/-/-	X/-/-

1 = Only operation of pulse-width modulated EEVs with ATV230

2 = No separate "cooling" switch signal

3 = No second fan level available

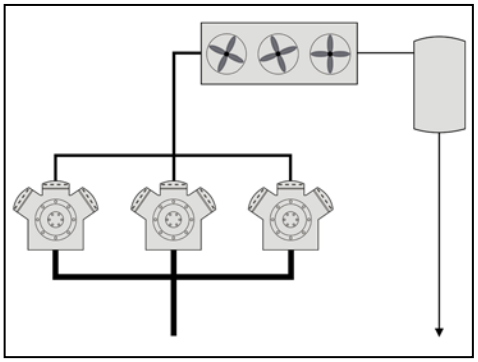
4 Compound control

4.1 Compound master modules

In the FRIGOLINK system, there are three different master modules with which the control of differentially complex equipment is possible.
Here the HVB-G3 and HVV-G3 cover the area of commercial compound control, while the HVI-G3 covers the area of industrial compound control.

4.2 Compound master module HVB-G3

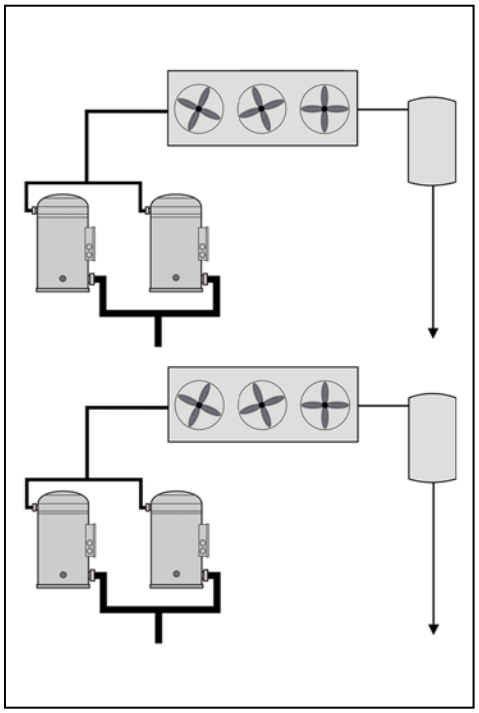
In the FRIGOLINK system, the HVB-G3 is the universal control for direct-evaporating systems and refrigerant equipment.
With its scope of functions, it covers broad areas of commercial refrigeration. The HVB-G3 is able to control a complete compound system with sophisticated suction pressure and condenser control and to monitor additional individual compressors.



HVB diagram

4.3 Double-compound master module HVV-G3

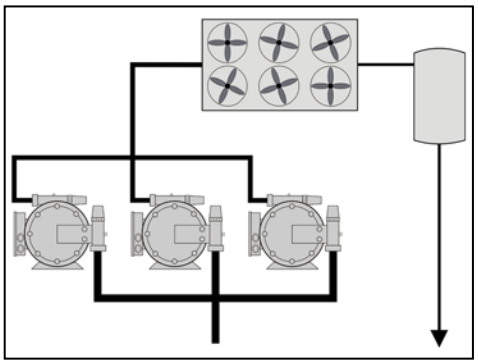
The double compound control HVV-G3 has a limited scope of functions compared to the HVB-G3.
This makes it the ideal controller for smaller, direct-evaporating compound systems. But it is able to control two complete compound systems for suction and condensation pressure independently of each other.



HVV diagram

4.4 Industrial compound master module HVI-G3

The HVI-G3 has a special position in the area of compound controllers. It is designed as a double compound controller and simultaneously has a number of additional control circuits, processes and functions that are optimised especially for control of industry compounds. It can trigger a larger number of field modules than the HVB-G3 or HVV-G3.



HVI diagram

4.5 Control circuits of the compound control

4.5.1 Control circuits "suction pressure" and "secondary refrigerant"

The compressors of the refrigerating equipment are regulated and monitored via the control circuits "suction pressure" and "secondary refrigerant". Various control strategies are available for triggering the compressors.

- **Multiple contact switch with base load change**
  The compressors are triggered via a multiple contact switch. The forward and return flow delays can be set independently of each other.

If necessary, there is the possibility of setting an individual delay time for the flow and return flow in each power stage of the compound. As a result, the compound can adapt better to the load profiles arising in the system.

The integrated base load change can be deactivated.

- **Master-slave for reducing switching play in industrial plants**
  This control process is especially suited for use with screw-type compressors. The master-slave switching of the compressors reduces mechanical changes and achieves a more even power adjustment of the compound. Load changes are largely set off by the master compressor. When additional compressors are switched on, the master compressor reduces its performance and thus achieves a better power adjustment between compound and cold locations.

- **Compressor control with frequency converter**
  The control process enables constant compound control with frequency converters: one or more compressors can be controlled constantly. Even a mixed operation with constant- and stepwise-controlled compressors is possible.

- **Triggering of screw-type compressors (constant, intermittent)**
  With this option, constant valve positioning can be performed especially for power regulation of screw-type compressors.
  In addition, an intermittent CR4-operation can also be implemented for Blitzer screws.

- **Cross-compound base load change**
  With the double-compound control HVI-G3, the base load change between both compounds of the master module can be coordinated via this function. The function is used especially in refrigerant equipment in which separate compressor racks have an impact on a common refrigerant circuit (redundancy).

- **Enthalpy-controlled suction pressure increase**
  By means of the enthalpy-controlled increase in suction pressure, the setpoint of the compound equipment can be raised dependent on the climate conditions (temperature and air humidity) in the showroom. The plant therefore follows the annual progression in terms of climate. Against good climatic conditions, for example, increasing the setpoint results in energy savings.

- **Dynamic flow/return flow delay**
  With this function, the delay times for the flow and return flow are dynamically adapted to the load conditions.
  With increasing deviations between setpoint and actual value, the delay times for the flwo and return flow are continuously reduced.
  As a result, the compound controls strong power oscillations more quickly.

- **Frigotakt+ (mass flow management)**
  Compressors are controlled with the optimised mass current management of the entire refrigeration plant. For this, data are exchanged constantly between compound and cold location controllers in order to achieve a co-ordinated switching of compressors and cold locations.

Besides evaluation of digital malfunction reports received, the following safety functions can be used:

- **Suction gas monitoring**
  Suction gas monitoring controls the superheating of the refrigerant vapour sucked in by the compound. A fault message is triggered with a time delay when the system falls below the alarm value. As a result, slugging on the compressors can be avoided or recognised early (possible causes are, for example, defective solenoid valves or dirty expansion valve nozzles).

- **Pump-Out for plant start and stop**
  A pump-out can also be performed when the compound is switched on or off. Evacuation of the plant when the compound is switched on and off reduces the risk of liquid slugging. In addition, leaking solenoid valves can be recognised.

- **Oscillation protection**
  The adjustable oscillation protection limits the max. number of compressor changes per hour.

- **T_0 too high / compound overload**
  The compound controller can recognise and report an overload of the compound.
  If all available compressors are switched on and the suction pressure T_0 rises above an adjustable tolerance value, a message is generated with a time delay via a switching contact.

- **Total breakdown of compressor rack**
  If the compound controller recognises a total breakdown of the compressor rack, the solenoid valves of the related cold location (FRIGOLINK) are switched off. This reduces the risk of liquid slugging when the compound is started.

- **Monitoring of the compressor end temperature**
  If the end temperature on the compressor exceeds a maximum value, the compressor involved is switched off, temporarily blocked and a fault message is generated.

4.5.2 Control circuit “condensation”

The “condensation” control circuit ensures control of the condensation pressure. Here, too, different control strategies can be applied:

- **Temperature recording T_C**
  For triggering of the fans, the condensation temperature T_C can be determined both from the condensation pressure p_C (with conversion to T_C) or by means of temperature sensors on the condenser.

- **Fan control constant and stepwise**
  The fans are triggered by a combination of constant PI controller and multiple contact switch. As a result, the fans can be triggered both constantly and stepwise or in a constant/stepwise combination.

- **Multi-circuit condenser**
  When several T_C sensors (pressure transmitters or temperature sensors) are used, a maximum selection of the temperature results automatically.

- **Outer-temperature-controlled setpoint increase**
  The condenser setpoint can be raised in dependence on the outer temperature. As a result, the condensation pressure continuously follows the external temperature and so always works at an economical operating point (energy savings).

Besides evaluation of digital fault inputs, the following safety functions can be used:

- **Monitoring of max. condensation pressure**
  If the condensation temperature T_C exceeds a maximum value, the condensation pressure controller triggers a load shedding onto the compressor compound (to avoid high pressure malfunctions).

4.5.3 Control circuit "free cooler"

The control circuit serves to regulate free coolers. It has a release logic that, besides the temperature in the free cooler, also includes the external and brine temperature. The fans of the free cooler are regulated using the free cooler temperature.

- **Fan control constant and stepwise**
  The fans are triggered by a combination of constant PI controller and multiple contact switch. As a result, the fans can be triggered both constantly and stepwise or in a constant/stepwise combination.

4.5.4 Control circuit "secondary refrigerant pumps"

The "SR pumps" control circuit is used to control and monitor the twin pump. Alternatively, operation of a single pump is also possible. A completely integrated release logic, which takes into account the fault status of the pumps as well as pressure switches and flow monitors, makes external wiring largely superfluous.

- **Base load change**
  The pumps are switched in a time-controlled way. The pump interval is adjustable by pump.
  An asymmetric pump interval is set as standard to increase the operational reliability.
  Alternatively, the base load change can be triggered externally.
- **Fault switchove**
  In case of faults (flow monitor, pressure switch, etc.), pump switchover takes place automatically (malfunctioning pump switches off – second pump switches on).
- **Compressor switch-off (protection against freeze-up)**
  To prevent freezing of the secondary refrigerant, the pump control brings the refrigeration plant compressors into fast return (e.g. when both pumps break down, frost protection malfunctions, etc.).
- **Various switchover modes**
  Various modes are available for pump switchover (overlapping / with and without pauses).

4.5.5 "Electronic expansion valves (EEV)" control circuit

The control circuit "EEV" can be used for superheating control of liquid subcoolers or refrigeration plant solenoid valves. The electronic expansion valves can either be controlled constantly or via pulse-width modulated signal (PWM).

4.5.6 "Single compressor" control circuit

This control circuit is used to monitor single compressors (e.g. separate satellite compressors for deep-freeze rooms, or the like). Manual interventions on the compressor are possible via switch cards or the manual/off/automatic inputs of the field modules. Control does not take place.

4.6 Overview of all compound master modules

Master module type	HVB-G3	HVV-G3	HVI-G3
Single-compound master module	X	-	-
Double-compound master module	-	X	X

Number of controllable field modules	8	8	12

Triggerable components			
FVB110B/FVB110-PAT, field module for 1 compressor	X	X	X
FVB120B/FVB120-PAT, field module for 2 compressors	X	X	X
FVB140B/FVB140-PAT, field module for 4 compressors	X	X	X
FVB240B/FVB240-PAT, field module for 4 condenser fans	X	X	X
FVB320B/FVB320-PAT, field module for 2 pumps	X	-	X
FIO001B/FIO-PAT, universal input and output module	X	X	X
FKV003, field module with output for EEV, for heat exchangers	X	X	X
SLD243-C, switch card for heat exchangers	X	X	X
SLD342-C, switch card for compressors, fans, pumps	X	X	X

Control circuits			
Suction pressure	X	X	X
Secondary refrigerant	X	-	X
Condensation	X	X	X
Pumps secondary refrigerant	X	-	X
Electronic expansion valve	X	X	X
Free cooler	-	-	X
Single machine	X	-	X

Control process and functions			
Suction pressure and secondary refrigerant			
Standard multiple contact switch with base load change	X	X	X
Master-slave for reducing switching cycles in industrial plants	-	-	X
Compressor control with frequency converter	X	X	X
Standard with variable delay times	-	-	X
Frigotakt+	X	X	X
Control of screw compressors (constant, intermittent)	-	-	X
Pump-out function with system stop	X	X	X
Pump out functions with compressor start/stop for single-circuit / multiple-circuit facilities	-	-	X
Cross-compound base load change	-	-	X
Enthalpy-controlled suction pressure increase	X	X	X
Dynamic flow control and return flow control	X	X	X
Monitoring of single compressors	X	-	X
Suction gas monitoring	X	X	X
Condensation			
Standard for fan stages (stepped and/or constant)	X	X	X
Speed and stages (combined)	X	X	X
Regulation according to condensation pressure or external temperature	X	X	X
Free cooler			
Standard for fan stages (stepped and/or constant)	-	-	X
Speed and stages (combined)	-	-	X
Pumps secondary refrigerant			
Base load switching	X	-	X
Fault switch-off with one pump	X	-	X
Fault switchover with two pumps	X	-	X
Various running modes for pump control	X	-	X
Electronic expansion valves			
Constant or by pulse-width modulated signal (PWM)	X	X	X
Cascade condenser	X	X	X
Suction restrictor	X	X	X

5 Characteristics in overview

System and components

- Flexible system configuration of master and field modules for every size plant, totally according to control requirements and plant specifications.
- System communication via CAN bus
- Two separate bus systems, subdivided into field bus and communication bus for especially high security.
- Expert database for fast placement into operation and optimal operation of the system through selection of stored plant types with standard control parameters.
- Individual adjustment of all control parameters is possible
- All set parameters are stored in the interchangeable memory module of the master module.
- Intelligent sensor management with automatic sensor recognition simplifies installation and operation of the plant.

Operation

- Simple management of the plant via the master module
- Simple addressing of the components

Faults and operating events

- Fault list as ring memory with 50 entries per master module
- After a fault occurs, the system automatically branches to the fault menu if the device has not been operated in the last 5 minutes.
- All faults are stored with their start and end times so the fault period can be read at a glance.
- Operating list as ring buffer with 25 occurred events that are displayed in plain text

Emergency operation

- FRIGOLINK has different emergency programs available in the various master and field modules that ensure secure operation of the equipment in the most varied of faults.

The exact descriptions of the various emergency programs can be found in the detailed function descriptions of the respective components in the FRIGOLINK Manual.

6 Validity of the documentation

Change	Functional upgrade	Page
2013-01	Basis of documentation	
2015-05	Documentation updates	

Any software versions not listed are special solutions for individual projects and are not described in detail in this document.

Please refer to the detailed descriptions in other chapters of the FRIGOLINK catalogue.

This document automatically becomes invalid if a new technical description is issued.