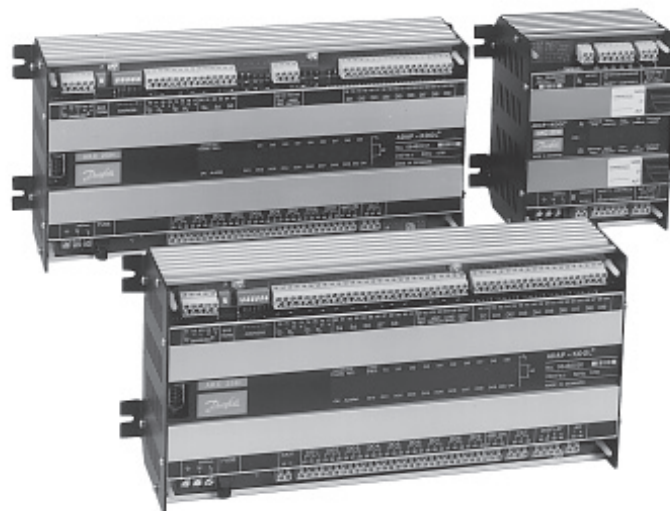


Technical brochure

## Compressor Pack Controllers

- AKC 25H1, AKC 25H3, AKC 25H5 and AKC 22H



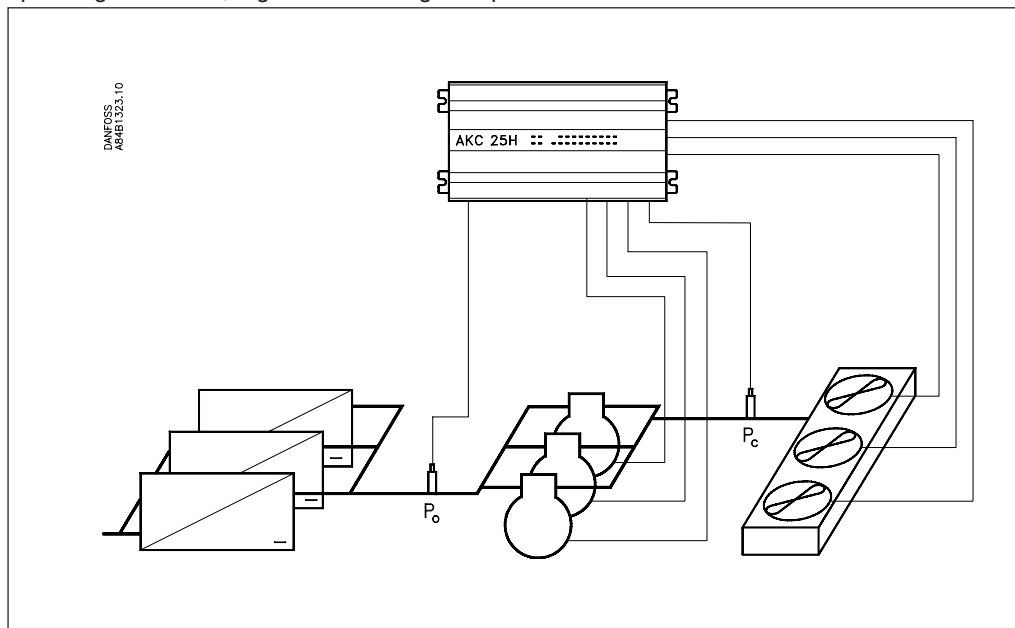
ADAP-KOOL®  
Refrigeration Control Systems

## Introduction

AKC 25H\_ is a complete control unit for capacity regulation of compressors and condensers in small refrigerating systems.

The controller can be used in combination with other controllers from Danfoss' ADAP-KOOL® refrigeration control system.

In addition to capacity regulation, the controller can send signals to other controllers about operating conditions, e.g. forced closing of expansion valves and alarms.



The controller's main function is to control compressors and condensers, so that they will continually work at the optimum suction and condensing pressures from an energy point of view. Both suction pressure and condensing pressure are controlled by signals from our pressure transmitters type AKS 32.

## Application

The controller can be used in refrigerating systems with piston compressors, which have one or more steps in, say:

- Supermarkets
- Small industrial systems

## Advantages

- Stable regulation of suction and condensing pressures
- Energy savings  
The controller adapts itself to the compressor and condenser capacities required for the actual load.
- Reliability  
Temperatures and functions are constantly monitored. When there is an alarm, the cause will be displayed on the control unit.
- PC connection  
When the system is linked up with a PC, central operation and data collection are made possible.
- Choice of refrigerant  
All types of refrigerants can be used, including ammonia.
- Definable outputs  
Any random combination of up to nine compressor and condenser steps can be defined.

## Controller types

The controller is available in three versions, AKC 25H1, AKC 25H3 and AKC 25H5, where the most important functional differences are:

AKC 25H1		<ul style="list-style-type: none"> <li>- Regulation of identical capacity steps</li> <li>- Monitoring of the whole compressor and condenser system</li> </ul>
AKC 25H3	<p style="text-align: center;">x 2</p>	<ul style="list-style-type: none"> <li>- Regulation of identical capacity steps in one or two compressor circuits and one or two condenser circuits</li> <li>- Regulation of both high pressure and low pressure</li> <li>- Speed regulation of condenser</li> <li>- Monitoring of the whole compressor and condenser system</li> </ul>
AKC 25H5		<ul style="list-style-type: none"> <li>- Regulation of identical or non-identical capacity steps as well as, e.g.:</li> <li>- Speed regulation of compressor or condenser</li> <li>- Heat recovery</li> <li>- Displacement of the condensing pressure reference as a function of the outdoor temperature</li> <li>- Monitoring of the whole compressor and condenser system</li> <li>- Displacement of the suction pressure reference as a function of a day/night clock or external reference</li> <li>- Peak load limitation</li> </ul>

Function overview	AKC 25-		
	H1	H3	H5
Neutral zone regulation of suction pressure	x	x	
Neutral zone regulation of condensing pressure	x	x	x
PI-regulation of suction pressure			x
PI-regulation of condensing pressure		x	x
Displacement of suction pressure reference via external reference		x	x
Displacement of suction pressure reference with a gateways master control function	x	x	x
Choice between automatic equalisation of operating time or fixed-sequence cutin and cutout	x	x	x
Time delays in connection with cutout and cutin	x	x	x
Hourmeter	x	x	x
Spare temperature sensor	x	x	x
Monitoring of pressures and temperatures	x	x	x
Monitoring of other control functions	x	x	x
Overriding of expansion valves	x	x	x
Monitoring of safety controls	x	x	x
Data communication	x	x	x
PC operation option	x	x	x
Alarm function with alarm messages	x	x	x
Night setback of suction pressure via external signal	x	x	x
Night setback of suction pressure via internal clock function		x	x
Connection of external alarm module type AKC 22H.	x	x	x
Regulation of two cooling circuits		x	
Control of compressors with different capacities, e.g. in a binary capacity combination			x
Possibility of variable speed regulation of compressor or condenser fan			x
Possibility of variable speed regulation of condenser fan or connection of a relay module for further step-by-step coupling of condenser steps		x	
Regulation based on measurement of relative humidity			x
Regulation of suction pressure based on room temperature			x
Regulation of condensing pressure based on outdoor temperature		x	x
Heat recovery function or liquid injection in suction line			x
Overriding of condensing pressure		x	
Connection of external display		x	x
Peak load limitation			x

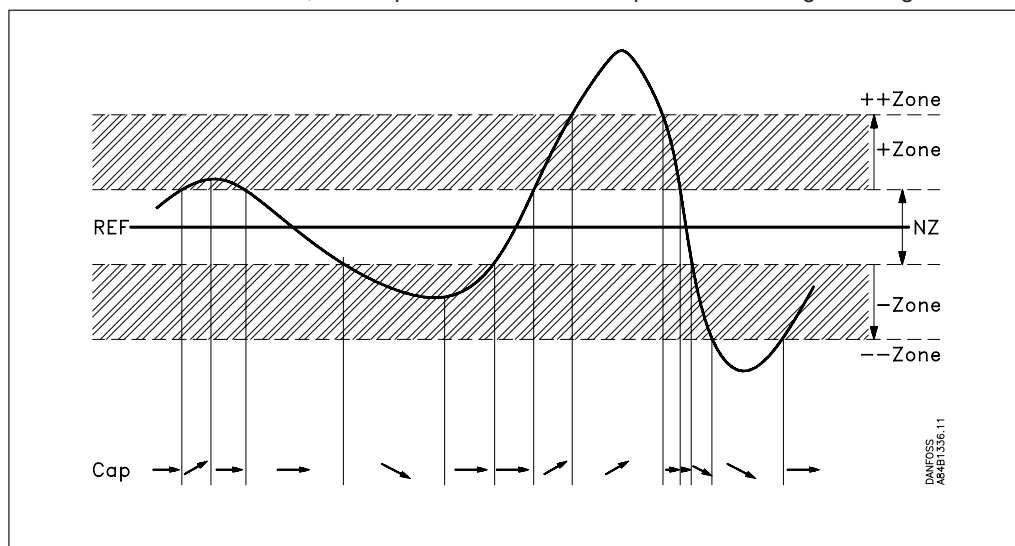
## Capacity regulation of compressors

### Definition of compressor

The controller can control up to nine compressor steps distributed on one or more compressors. (In AKC 25H1 regulation is based on all connected compressor steps being the same size, but it is not a requirement that they are the same size although improved regulation will be obtained in this way. In AKC 25H5 optimum regulation can be carried out with different capacity step sizes).

### Regulation

The cut-in compressor capacity is controlled by the actual value of the suction pressure in relation to a reference value, and depends on whether the pressure is rising or falling.



Regulation takes place according to the neutral zone principle:

- In the neutral zone there is no cutin/ cutout of capacity steps.
- In the +zone and -zone band cutin/cutout will take place with selected time delays that depend on whether the pressure is rising or falling.
- In the ++zone and --zone band, cutin/cutout will take place with selected time delays.

In AKC 25H5 a PI regulation handles the capacity control, but the settings are made are the same simple settings that are shown above.

### Displacement of suction pressure reference

The reference value for the regulation can be displaced by means of various functions:

- An external voltage signal transmitted to the "Ext. Ref" terminal. (AKC 25H3 except)  
In AKC 25H5 this voltage signal can also be based on a measurement of the relative air humidity.
- A night setback signal connected to an input. The signal must shortcircuit the input. The signal can also be generated with a setting in the controller.  
In AKC 25H3 and -5 this night setback signal may also be generated by an internal clock signal where a time schedule for day and night times for the different weekdays has been set beforehand.
- In AKC 25H5 the reference may also be displaced as a function of a temperature measurement
- Signal from the gateway's override function  
A signal can be received from an override function via DANBUSS. When the signal is received, there will be change-over to night operation.

### Signal from the compressor's safety controls

The controller must receive signals about the status of each compressor's safety circuit. The signal is taken directly from the safety circuit and sent to a "DI" input. If the safety circuit is cut out, the controller will cut out all output relays for the compressor in question and send an alarm. The remaining compressors will continue the regulation.

### Sequence for cutin and cutout of capacity

The sequence for cutin and cutout of capacity can be defined in three ways:

#### 1. Sequential

For one-step compressors the sequence is not changed. The last cut-in step will be cut out first when the required capacity is again falling.

In multi-step compressors a change takes place of the steps on the borderline between the two compressors. The compressor last started will not stop until the control has cut out the "last" step of the previous compressor.

#### 2. Automatic equalisation of operating time between compressors.

#### 3. Binary capacity combination (AKC 25H5 only).

### Time delays for cutins and cutouts

To protect the compressor motor and the unloaders against frequent restarts, two time delays can be set for each relay output controlling a compressor motor.

### Hourmeter

The operating time of the various outputs is registered by a counter. This registration can be displayed and/or reset.

### Coupling counter

The number of compressor motor start-ups is registered by a counter. Here it can be seen how many times the compressor has started during the past 24 hours.

### Temperature sensor

It is possible to connect an additional temperature sensor for measuring, say, the air temperature in the machine room.

## Capacity regulation of condensers

### Definition of condenser

The controller can control several condenser steps.

(The controller has a total of nine relay outputs to be distributed between compressor steps and condenser steps).

### Regulation

The cut-in condenser capacity is controlled by the actual value of the condensing pressure in relation to a reference value and depends on whether the pressure is rising or falling.

### Signal from the condenser fans' motor protector

The controller can receive signals about the status of each condenser step's motor protector. The signal is taken directly from the motor starter and sent to a "DI" input.

If the signal is cut out, the controller will cut out the output relay for the relevant step and give an alarm. The remaining steps will continue the regulation.

### Hourmeter

The operating time of the various outputs is registered by a counter. This registration can be displayed and/or reset.

### Coupling counter

The number of condenser motor start-ups is registered by a counter. Here it can be seen how many times the fan has started during the past 24 hours.

### Displacement of condenser pressure reference (except AKC 25H1)

The regulation reference can be displaced with the following signals:

- Signal from a temperature sensor  
The condensing pressure follows variations of the outdoor temperature, so that operation takes place with the lowest possible condensing pressure as a function of the actual compressor capacity.
- Signal from the TC output on AKC 114D-116D controllers (AKC 25H5 only)  
The condensing pressure is lowered by a set value when all AKC 114D-116D controllers permit it.

### Speed control

AKC 25H3 and AKC 25H5 only

The controllers have an analog output that can be used in the following way:

AKC 25H3

The output can speed-regulate the condenser fan via a VLT® frequency converter or control a step coupling relay type EKC 331. A signal from 0 to 10 V indicates the capacity.

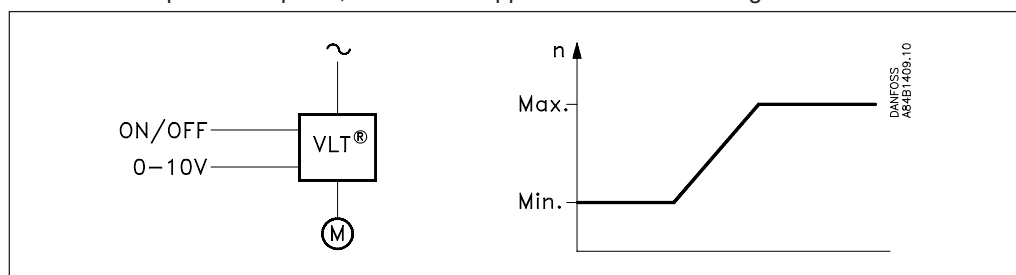
AKC 25H5

The output can speed-regulate the condenser fan or a compressor motor via a VLT® frequency converter.

One of the controller's output steps (ON/OFF) is defined for the variable speed regulation.

A signal from 0 to 10 V from the analog output indicates the capacity.

Settings in the controller will ensure that the capacity regulation utilize the whole range between the minimum and maximum speeds which the frequency converter is set for. If a lower speed than the min. speed is required, the unit is stopped via the ON/OFF signal.

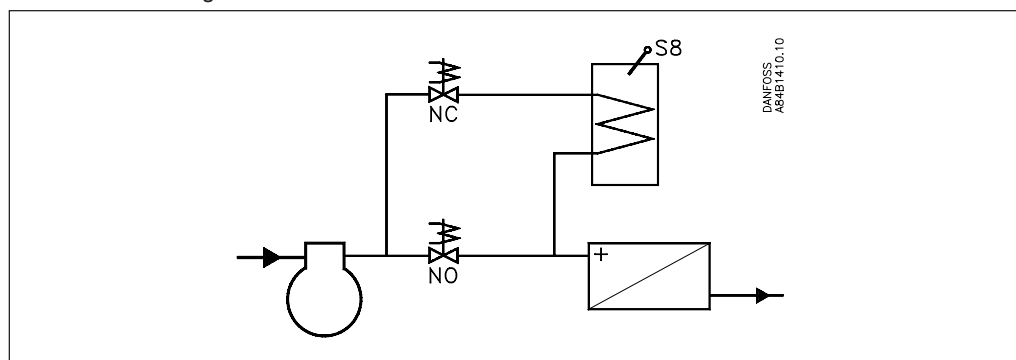


Speed control may be carried out in the range between 10 and 150%, when a condenser is controlled, and between 50 and 120%, when a compressor is controlled.

### Heat recovery

AKC 25H5 only

Via a temperature measurement on the S8 input and a solenoid valve on the AKV output the controller can operate a heat recovery function where the condenser heat is used for either hot water or air heating.



The temperature at the S8 sensor is compared with a set temperature. When heat for the recovery function is then required, the solenoid valves will be activated and the condensing pressure raised. When the temperature has been reached, the power to the solenoid valves is interrupted, and the displacement of the condensing pressure ceases.

AKC 25H3 only:

Via signal at the D18/D19 inputs the condensing pressure setpoint can be raised.

## Monitoring

### Monitoring of max. discharge temperature

The function cuts out half of the compressor steps when the pressure gas temperature approaches the max. permissible value (AKC 25H3 cuts out between 33% and 50% depending on the defined capacity). If this value is exceeded, all compressor steps will immediately be cut out.

The discharge temperature is measured with the temperature sensor on the Sd input.

### Monitoring of max. condensing pressure

The function cuts in condenser steps and cuts out half of the compressor capacity, if the condensing pressure approaches the max. permitted value. If this value is exceeded, all compressor steps will immediately be cut out.

The condensing pressure is measured with the pressure transmitter on the Pc input.

### Monitoring of minimum suction pressure

The function will promptly cut out all compressor steps if the suction pressure drops below the permitted min. value.

The suction pressure is measured with the pressure transmitter on the P0 input.

### Monitoring of superheat (AKC 25H1 and AKC 25H5 only)

The function gives alarm if the superheat rises above or falls below the defined values.

The superheat is measured with the pressure transmitter on the P0 input and the temperature sensor on the Ss input.

AKC 25H5 furthermore contains a function that will start liquid injection in the suction line, if the superheat becomes too high.

### Monitoring of other controls

The controller is provided with nine digital inputs. Some of the inputs can be used for information relating to the status of the safety circuit for the individual compressors, others for the individual condenser steps. The remaining inputs may be used for other purposes to the required extent. If an input is used for another purpose, an alarm text can be defined which is transmitted when the input is cut out. The following alarm text can be defined in AKC 25H1 and AKC 25H5 (in AKC 25H3 the alarm text is "General Alarm"):

- Low liquid level
- Refrigerant leak
- Current fault
- Phase fault
- Liquid flow switch
- Air flow switch
- Speed control fault
- Condensate pump fault
- High condensate level

### Limitation of compressor capacity during peak loads

AKC 25H5 can receive a signal from other control units that monitor the installation's power consumption.

If the limit value for the power consumption is reached, a signal is transmitted to AKC 25H5.

The controller will now see to it that only a limited part of the compressor capacity is cut in.

### Overriding

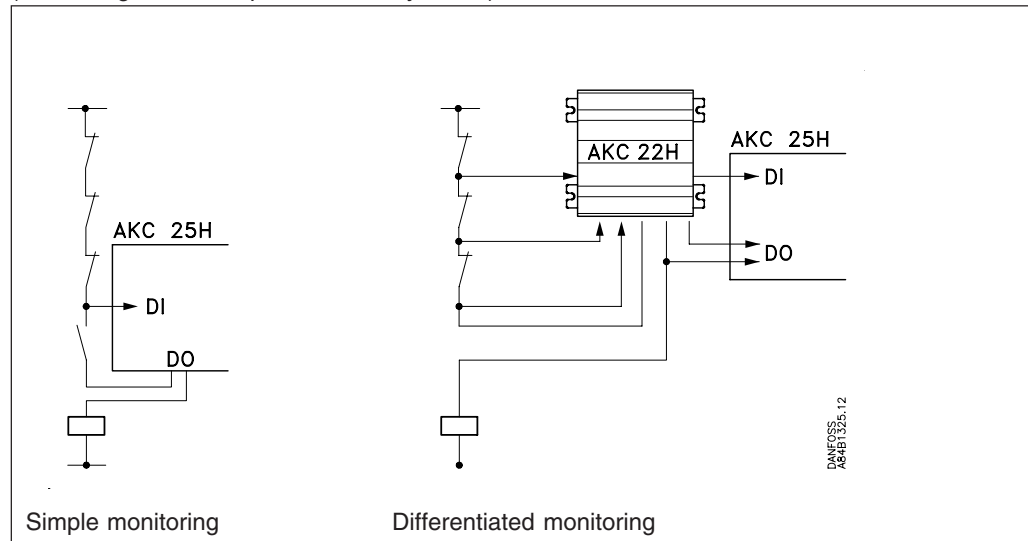
Forced-closing signal to AKC 114, 115 and 116 controllers

The controllers' AKV valves must be closed with an external signal, if the compressors have stopped for one reason or another (the controllers' ON input is cut out). The compressor control supplies this signal, so that no liquid will be injected into the evaporator when the compressor has stopped.

If the controllers are installed together with a gateway type AKA 243 or AKA 244, this override can be transmitted via the data communication. In this way the line connections between the controllers can be reduced to a minimum.

### Safety circuit status

(Monitoring of the compressor's safety circuit)



#### Simple monitoring

The safety circuit is connected to a digital input on the controller. If the safety circuit is cut out, the controller will give an alarm and keep on regulating with the remaining compressors.

#### Differentiated monitoring

The simple monitoring of the safety circuit may be extended with an alarm module type AKC 22H. This unit can give a definitive alarm message indicating where the safety circuit has fallen out.

The connections and the individual alarm messages have been fixed and cannot be changed (cf. the functional description).

Up to four alarm modules can be connected to one controller. Each alarm module can monitor two safety circuits.

The alarm module is furthermore provided with a switch with which the regulation can be stopped and the compressors cut-in manually without the primary safety circuits being put out of function.

### Sensor failure

If a missing signal is registered by one of the connected temperature sensors or pressure transmitters, there will be an alarm. If the pressure transmitter "P0" is faulty, the refrigeration will immediately be stopped. In AKC 25H3 the refrigeration is however continued with the average compressor capacity registered by the controller during the past 48 hours.

### Display of values (AKC 25H3 and AKC 25H5 only)

Many of the values the controller is operating with can be shown on a separate display type AKA 14. As many as ten values can be shown, and the display is determined by the setting of a switch connected to the controller.



## Operation

### Operation

All settings and measurements are presented via a menu system. The menu system can be displayed via our DANBUSS Data Communication on one of the following two operating interfaces:

#### Control panel type AKA 21

The control panel is connected to the network, or, controller the different settings and displays can now be arranged via the menu system.

Two types of access codes can be defined which will subsequently limit the access to the controller.

Code 1 will give access to a limited part of the unit's functions.

Code 2 will give access to all the unit's functions.

#### System software type AKM

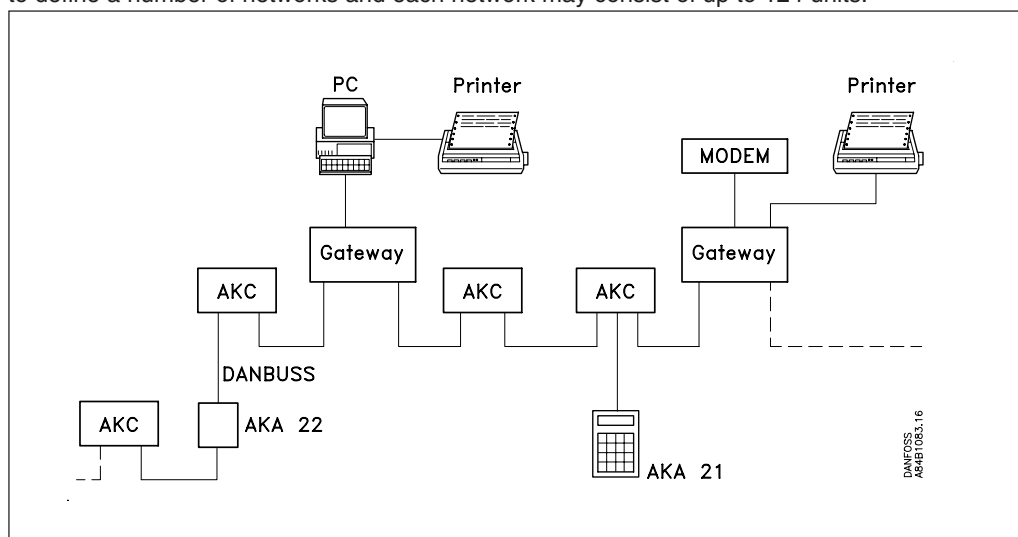
DANBUSS Data Communication can be connected to a PC via a gateway type AKA 243/244.

The software programme "System software type AKM" is installed on the PC. When this has been accomplished, all settings, displays and receipt of alarms can take place from the PC.

Via an authorisation system each user may be granted access to selected functions.

### Data communication

Data communication between AKC 25H\_ controllers and other units in the ADAP-KOOL® product range of refrigeration controls takes place via an RS 485 bus standard. The protocol is a DANFOSS standard with the registered name DANBUSS. Here it is possible to define a number of networks and each network may consist of up to 124 units.



The system is operated either by:

#### 1. Using control panel type AKA 21.

The control panel may either be stationary or a portable model. One control panel may be common to several controllers.

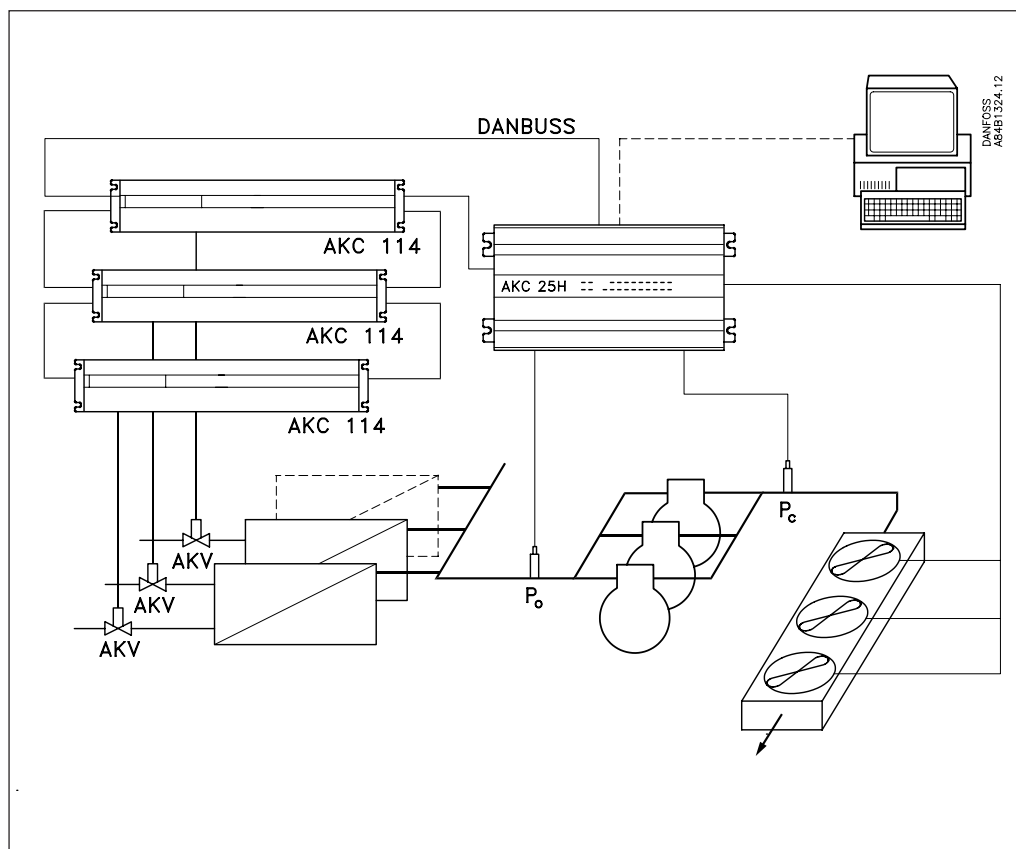
#### 2. Using a PC.

The PC is connected via a DANFOSS gateway type AKA 243/244. Monitoring of the system and collection of data are possible, when a PC is used.

Communication via a modem connection.

Operation can subsequently take place, as described above.

## Application example 1

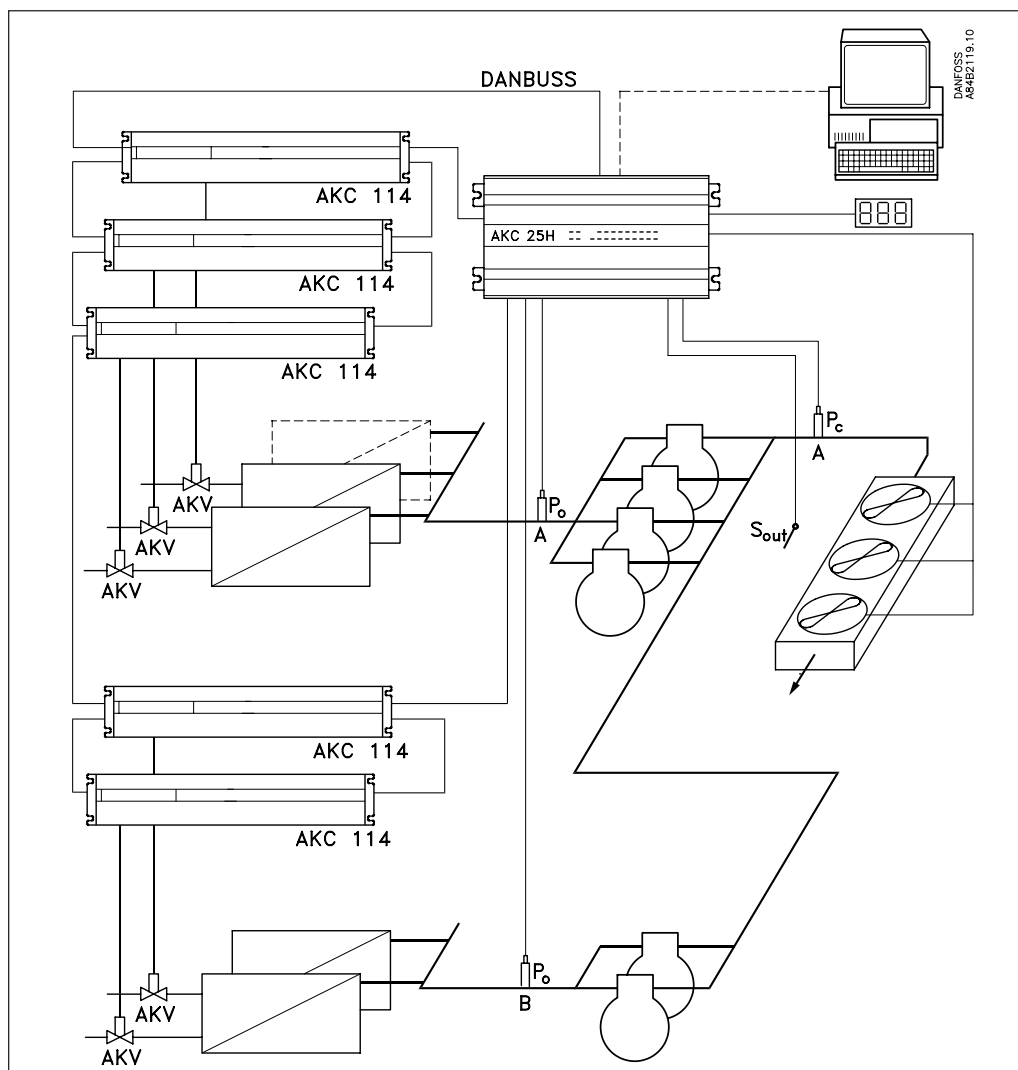


AKC 25H1 installed in a supermarket where the refrigerating system consists of:

- three compressors in a power pack. Each compressor has two steps
- one condenser with three steps
- a number of refrigeration appliances controlled by controllers type AKC 114 with AKV valves

- Regulation is based on signals from two pressure transmitters (suction pressure with P0 and condensing pressure with Pc).
- During the night a few refrigeration appliances are covered with night blinds and there is a change over to regulation with a higher suction pressure.
- If a compressor or a condenser step is stopped by the safety controls, the remaining compressors will continue the regulation.
- A setting in the controller will ensure that the operating time of the three compressors will be equal.
- In situations where all compressors are stopped, a signal will be sent to the AKC 114 controllers. This will close all the belonging AKV valves, so that refrigeration is discontinued. When the compressors are started again, it will be with optimum refrigeration and without any liquid in the evaporator.
- Operation via a PC will ensure a correct function all the time, with instantaneous alarm in the event of problems. Early registration of a fault will reduce the risk of damage to products. Alarms can be received on the spot, or they may via data communication be transmitted to a central location.  
The entire operating interface may be extended with a modem connection, so that the operation can be handled by a centrally located service company.

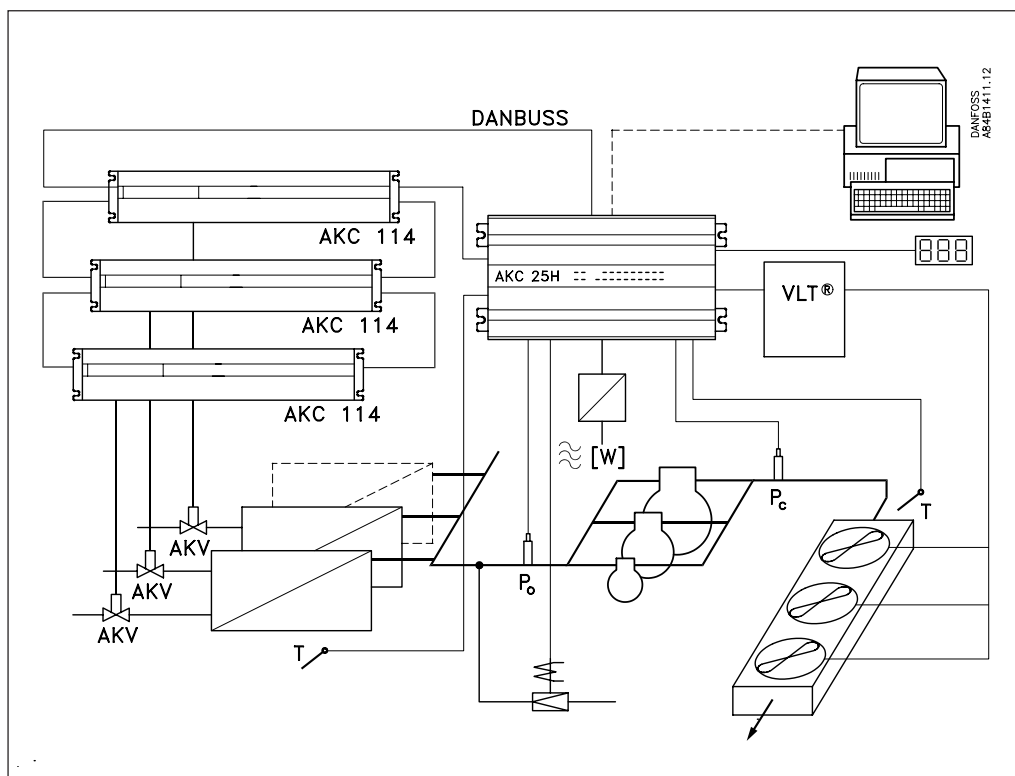
## Application example 2



AKC 25H3 installed in a supermarket where the refrigerating system consists of:

- 4 compressors in a power pack, supplying energy to the refrigerated cabinets.
- 2 compressors in a power pack, supplying energy to the freezer cabinets
- one common condenser with three steps
- a number of refrigeration appliances controlled by controllers type AKC 114 with AKV valves
- Regulation is based on signals from three pressure transmitters and one temperature sensor
- The condensing pressure reference is adapted to the outdoor temperature.
- The fans in the condenser are step-controlled, so that the condensing pressure is kept at the required level.
- The suction pressure is raised during the night according to a internal time schedule.
- The different pressures and temperatures are shown on a separate display. You change between the different values with a switch.
- If a compressor or condenser step is stopped by the safety controls, the regulation will continue with the remaining controls.
- A setting in the fan will ensure that a group of compressor's running time remains the same all the time.
- In situations where all compressors are stopped, a signal will be sent to the AKC 114 controllers. This will close all the belonging AKV valves, so that refrigeration is discontinued. When the compressors are started again, it will be with optimum refrigeration and without any liquid in the evaporator.
- Operation via a PC will ensure a correct function all the time, with instantaneous alarm in the event of problems. Early registration of a fault will reduce the risk of damage to products. Alarms can be received on the spot, or they may via data communication be transmitted to a central location.  
The entire operating interface may be extended with a modem connection, so that the operation can be handled by a centrally located service company.

### Application example 3



This example is based on the same installation as in example 1, but capacity controller type AKC 25H5 has been installed.

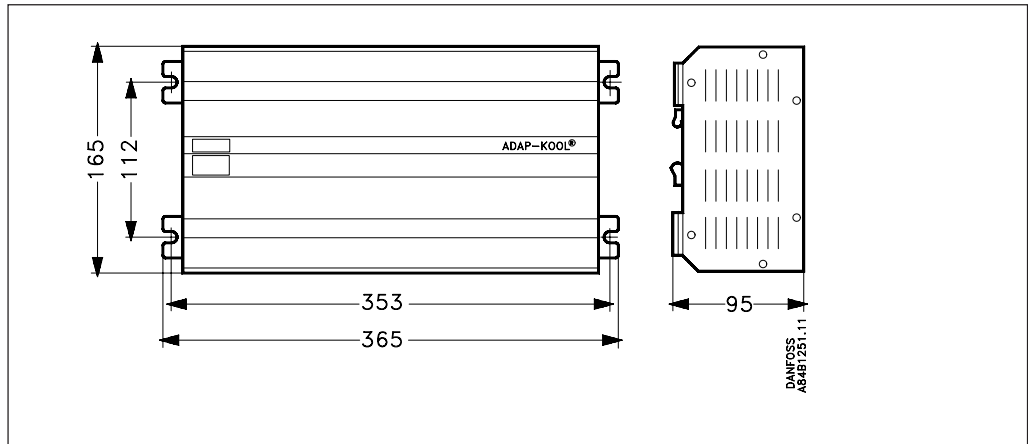
This offers you a number of options beyond the ones mentioned in example 1.

- The fans in the condenser are speed-regulated by a frequency converter, so that the condensing pressure is constantly kept at the required level.
- The condensing pressure reference is adapted to the outdoor temperature.
- The suction pressure is raised during the night according to a defined time schedule.
- The suction pressure increase depends on the room temperature.
- During periods where the total power consumption is high the compressor capacity is kept down at, say, 66% of the max. capacity. In other words, only two compressors are permitted to operate when there are peak loads on the electrical supply.
- The different pressures and temperatures are shown on a separate display. You change between the different values with a switch.
- The superheat of the suction gas is limited by means of liquid injection in the suction line.

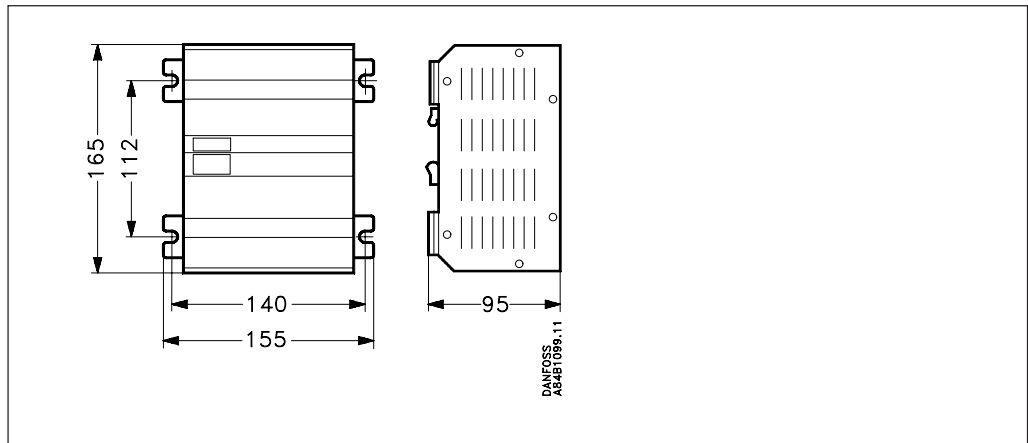
**Technical data**

Supply voltage	230 V a.c. +10/-15%, 50/60 Hz. 12 VA			
Fuse	Ø5 x 20 mm 1 A T 250 V			
Inputs	Temperature sensors type AKS 21	Pt 1000 ohm	Number: 3 (AKC 25H1) Number: 7 (AKC 25H3) Number: 5 (AKC 25H5)	
		Temperature range	-70°C to 160°C	
	Pressure transmitter type AKS 32	P0	1 only(-1 to 12 bar, 1 to 5 V) (2 in AKC 25H3)	
		Pc	1 only(-1 to 34 bar, 1 to 5 V) (2 in AKC 25H3)	
	Signal from safety controls	Number	9	
		Voltage	Alarm: U < 30 V a.c. OK: U > 195 V a.c.	
	Switch for regulation	Number	1	
		Requirements to the type	Signal switch (12 V)	
	Voltage signal	Displacement of reference voltage	0 to 10 V (Not AKC 25H3)	
		Signal from Tc function	1 only (AKC 25H5 only) (230 V).	
Resistance measurements	Signal from power meter	Short circuit /open. Signal switch (AKC 25H5 only)		
	Switch for change of display	0-1000 ohm (Not AKC 25H1)		
Outputs (relay)	Compressor and condenser step		Number: 9	
	"AKC ON" signal		Number: 1 (2 in AKC 25H3)	
	Alarm		Number: 1	
	Voltage	48 to 256 V a.c. 10 to 256 V a.c. for alarm relay		
	Imax.	AC-1	3 A (ohmic)	
		AC-15	1,5 A (inductive)	
Pmin.	1 VA			
Other outputs	AKV valve	230 V d.c. (solid state)	1 only (AKC 25H5 only, max. 40W)	
	Display	Digital	1 only (AKC 25H3 / 5 only)	
	For speed control	0-10 V d.c.	1 only (AKC 25H1 only)	
Refrigerant	All, NH3 also (special refrigerants are set with 3 constants)			
Data communication	Hardware	RS 485		
	Software	DANBUSS		
Operation	Control panel	AKA 21		
	PC System software	AKM		
Ambient temperature	During operation	-20 to +55°C		
	During transport	-50 to +70°C		
Enclosure	Material	Anodised aluminium		
	Density	IP 10, VBG 4		
	Weight	2.5 kg		
	Mounting	On wall or DIN rail. Fittings are bypacked. The controller can also be installed on a table front by means of a panel bracket.		

Dimensions



AKC 25H1, AKC 25H3 and AKC 25H5



AKC 22H

## Ordering

Type	Function	Language	Code No.
AKC 25H1	Compressor control	English, German, French	<b>084B2017</b>
		English, Spanish, Danish	<b>084B2018</b>
AKC 25H3	Double Compressor control	English, German, French Spanish, Danish	<b>084B2039</b>
AKC 25H5	Extended compressor control	English, German, French	<b>084B2020</b>
		English, Spanish, Danish	<b>084B2021</b>
AKC 22H	Alarm module		<b>084B2050</b>

## Literature

Technical brochure AKC 25H (this document) .....	RC.1J.4
Catalogue. Pressure transmitters type AKS 32 .....	RK.0Y.G
Catalogue. Temperature sensors .....	RK.0Y.G
Function description AKC 25H1 .....	RC.1J.Z
Function description AKC 25H3 .....	RC.8A.H
Function description AKC 25H5 .....	RC.1J.5
Installation guide for Data communication cable .....	RC.0X.A
Mounting instructions AKC 25H1 (bypacked unit) .....	RI.1J.T
Mounting instructions AKC 25H3 (bypacked unit) .....	RI.8A.U
Mounting instructions AKC 25H5 (bypacked unit) .....	RI.1J.Z
Mounting instructions AKC 22H (bypacked unit) .....	RI.1J.U
Menu operation via AKA 21, AKC 25H1 (software-based) .....	RC.1J.X
Menu operation via AKA 21, AKC 25H3 (software-based) .....	RC.8A.F
Menu operation via AKA 21, AKC 25H5 (software-based) .....	RC.1J.2
Menu operation via AKM, AKC 25H1 (software-based) .....	RC.1J.V
Menu operation via AKM, AKC 25H3 (software-based) .....	RC.8A.G
Menu operation via AKM, AKC 25H5 (software-based) .....	RC.1J.3
Table for entry of menu settings AKC 25H1 (bypacked unit) .....	RI.1J.V
Table for entry of menu settings AKC 25H1 (bypacked unit) .....	RI.1J.3
Table for entry of menu settings AKC 25H3 (bypacked unit) .....	RI.8A.V
Table for entry of menu settings AKC 25H5 (bypacked unit) .....	RI.1J.0
Table for entry of menu settings AKC 25H5 (bypacked unit) .....	RI.1J.1

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