User manual

Electronic superheat controller Type EKC 312



The controller and valve can be used where there are requirements to accurate control of superheat in connection with refrigeration.
- Processing plant (water chillers)
- Cold store (air coolers)
- A/C plant

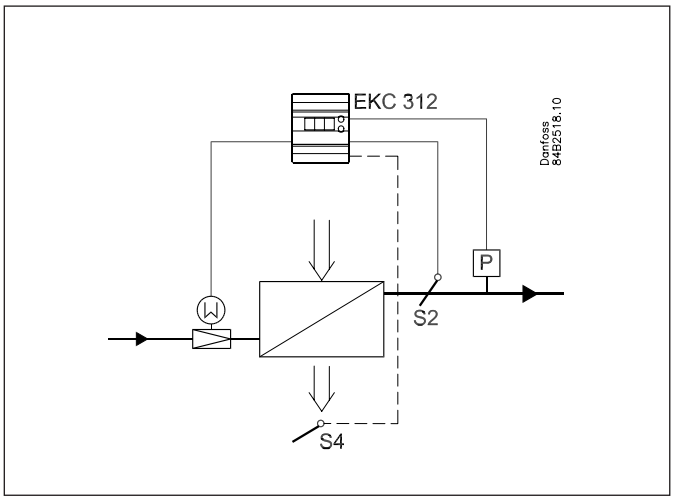
Features

- The evaporator is charged optimally – even when there are great variations of load and suction pressure.
- Energy savings – the adaptive regulation of the refrigerant injection ensures optimum utilisation of the evaporator and hence a high suction pressure.
- The superheating is regulated to the lowest possible value.

Introduction

Application
The controller and valve can be used where there are requirements to accurate control of superheat in connection with refrigeration.
E.g.:

- Processing plant (water chillers)
- Cold store (air coolers)
- A/C plant



Advantages

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- Energy savings – the adaptive regulation of the refrigerant injection ensures optimum utilisation of the evaporator and hence a high suction pressure.
- The superheating is regulated to the lowest possible value.

Functions

- Regulation of superheat.
- MOP function.
- ON/OFF input for start/stop of regulation.
- PID regulation.

System
The superheat in the evaporator is controlled by one pressure transmitter P and one temperature sensor S2.
The expansion valve is with step motor of the type ETS.

For safety reasons the liquid flow to the evaporator must be cut OFF if there is power failure for the controller. As the ETS valve is provided with step motor, it will remain open in such a situation.

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Operation

Superheat function

- Adaptive superheat

MOP

The MOP function limits the valve's opening degree as long as the evaporating pressure is higher than the set MOP value.

External start/stop of regulation

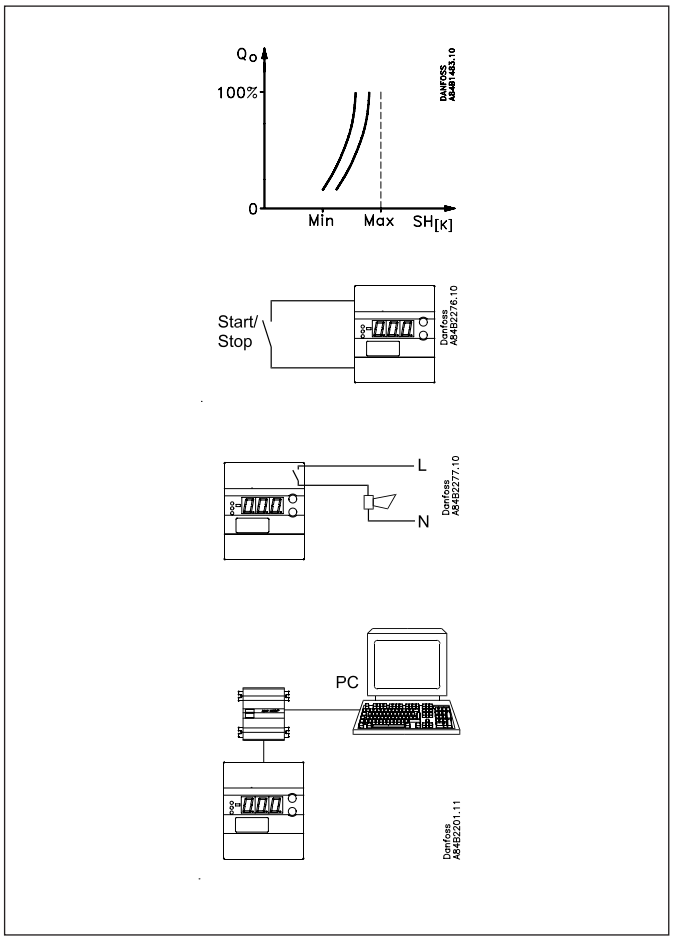
The controller can be started and stopped externally via a contact function connected to input terminals 1 and 2. Regulation is stopped when the connection is interrupted. The function must be used when the compressor is stopped. The controller then closes the solenoid valve so that the evaporator is not charged with refrigerant.

Alarm relay

The relay for the alarm function works in such a way that the contact is cut in in alarm situations and when the controller is de-energised.

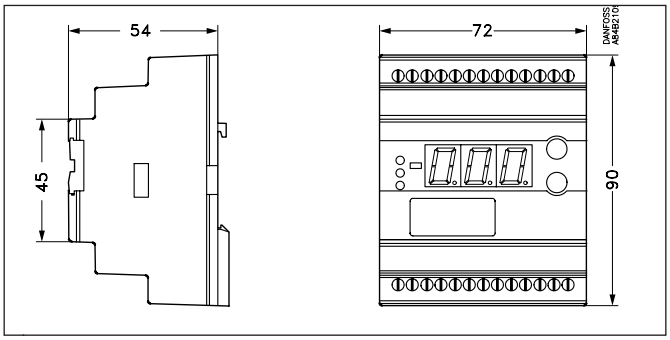
PC operation

The controller can be provided with data communication so that it can be connected to other products in the range of ADAP-KOOL® refrigeration controls. In this way operation, monitoring and data collection can be performed from one PC – either on the spot or in a service company.



Data

Supply voltage	24 V AC +/-15% 50/60 Hz, 10 V A (the supply voltage is galvanically separated from the input and output signals)	
Power consumption	Controller ETS step motor	5 V A 1,3 V A
Input signal	Press. transmitter	4-20 mA from AKS 33
	Digital input from external contact function	
Sensor input	2 pcs. Pt1000 ohm	
Alarm relay	1 pcs. SPST	AC-1: 4 A (ohmic) AC-15: 3 A (inductive)
Step motor output	Pulsating 100 mA	
Data communication	Possible to connect a data communication module	
Ambient temperature	-10 – 55 °C, During operation -40 – 70 °C, During transport	
	20 – 80% Rh, not condensed	
	No shock influence/vibrations	
Enclosure	IP 20	
Weight	300 g	
Mounting	DIN rail	
Display	LED, 3 digits	
Approvals	EU Low Voltage Directive and EMC demands re CE-marking complied with. LVD-tested acc. to EN 60730-1 and EN 60730-2-9 EMC-tested acc. to EN50081-1 and EN 50082-2	



Ordering

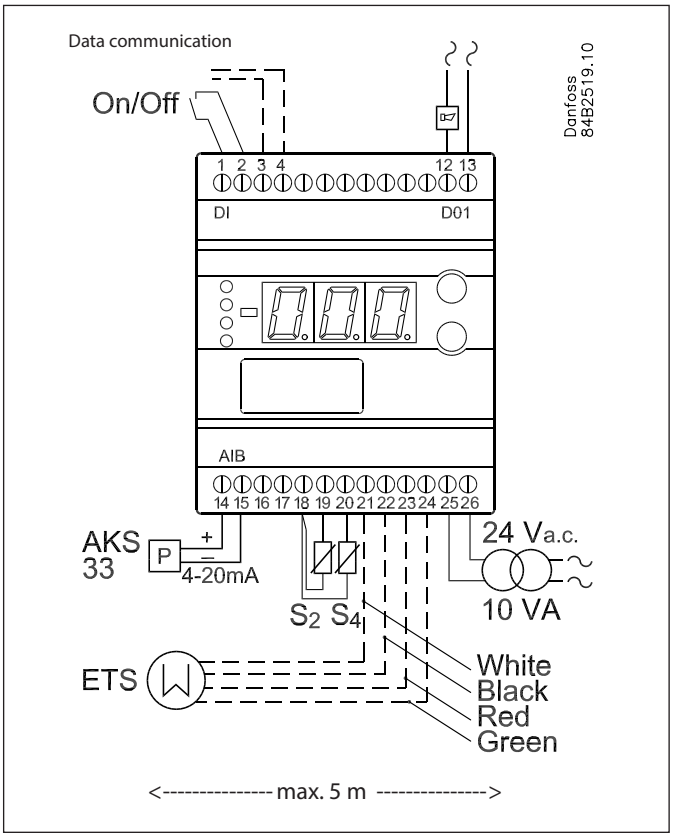
Type	Function	Code No.
EKC 312	Superheat controller	084B7250
EKA 173	Data communication module (accessories), (FTT 10 module)	084B7092
EKA 175	Data communication module (accessories), (RS 485 module)	084B8679
EKA 174	Data communication module (accessories), (RS 485 module) with galvanic separation	084B7124

Temperature sensor Pt 1000 ohm / Pressure transmitter type AKS 33: Kindly refer to catalogue RK0YG ETS valves: Kindly refer to data sheet RD1TA

Connections

Necessary connections
Terminals:
25-26 Supply voltage 24 V AC.
21-24 Supply to step motor
18-19 Pt1000 sensor at evaporator outlet (S2)
14-15 Pressure transmitter type AKS 33
1-2 Switch function for start/stop of regulation. If a switch is not connected, terminals 1 and 2 must be shortcircuited.

Application dependent connections
Terminal:
18-20 Pt1000 sensor for measuring air temperature (S4)
12-13 Alarm relay
There is connection between 12 and 13 in alarm situations and when the controller is dead
3-4 Data communication
Mount only, if a data communication module has been mounted.
It is <u>important</u> that the installation of the data communication cable be done correctly. Cf. separate literature No. RC8AC...



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Survey of functions

Function	Parameter	Parameter by operation via data communication
Normal display		
Normally the superheat is shown (but the valve's opening degree or air temperature may also be selected. See o17.		SH / OD% / S4 temp
Reference		**Thermostat control**
Unit Here you select whether the controller is to indicate the temperature values in °C or in °F. And pressure values in bar or psig. If indication in °F is selected, other temperature settings will also change over to Fahrenheit, either as absolute values or as delta values. The combination of temperature unit and pressure unit is depicted to the right.	r05	Units (Menu=Misc.) 0: °C + bar 1: °F + psig (in AKM only °C + bar – is displayed – whatever the setting)
Start/stop of refrigeration With this setting refrigeration can be started and stopped. Start/stop of refrigeration can also be accomplished with the external switch function. See also appendix 1.	r12	Main Switch
Alarm		**Alarm setting**
The controller can give alarm in different situations. When there is an alarm all the light-emitting diodes (LED) will flash on the controller front panel, and the alarm relay will cut in.		
Control parameters		**Injection control**
P: Amplification factor Kp If the Kp value is reduced the regulation becomes slower.	n04	Kp factor
I: Integration time Tn If the Tn value is increased the regulation becomes slower.	n05	Tn sec.
Max. value for the superheat reference	n09	Max SH
Min. value for the superheat reference Warning! Due to the risk of liquid flow the setting should not be lower than approx. 2-4 K.	n10	Min SH
MOP If no MOP function is required, select pos. Off.	n11	MOP (bar) (A value of 20 corresponds to Off)
Amplification factor for the superheat This setting determines the valve's opening degree as a function of the change in evaporating pressure. An increase of the evaporating pressure will result in a reduced opening degree. When there is a drop-out on the low-pressure thermostat during start-up the value must be raised a bit. If there is pendling during start-up the value must be reduced a little. The value should only be changed by specially trained staff.	n20	Kp T0
Value of min. superheat reference for loads under 10% (The value must be smaller than "n10").	n22	SH Close
The parameters "n37" and "n38" are settings for step motor ETS 100. The settings must be changed when another valve is used.		
Number of steps from 0% to 100% open	n37	Max. steps (0 - 5000 step)
Spindle stroke speed (number of steps per second)	n38	Steps / sec (10 - 300 step/sec)
Integration time for the inner loop gain Used only when o56=2. The value should only be changed by specially trained staff.	n44	TnT0 sec

Survey of functions

Function	Parameter	Parameter by operation via data communication
Miscellaneous		**Miscellaneous**
Address If the controller is built into a network with data communication, it must have an address, and the master gateway of the data communication must then know this address. These settings can only be madewhen a data communication modulehas been mounted in the controller and the installation of the data communication cable has been completed. This installation is mentioned in a separate document "RC8AC".		Following installation of a data communication module, the controller can be operated on a par with the other controllers in ADAP-KOOL® refrigeration controls
The address is set between 1 and 60 (119)	o03	-
The address is sent to the gateway when the menu is set in pos. ON (The setting will automatically change back to Off after a few seconds).	o04	-
Frequency Set the net frequency.	o12	50/60 Hz (50=0, 60=1)
Select signal for showing display Here you can select the signal to be shown in the normal display. The signal is also transmitted to the analog output. See o09. 1: Superheat 2: Valve's opening degree 3: Air temperature (If you during operation give the lower button a brief push, you can see the following: The S4 temperature, if 1 has been selected. The superheat reference, if 2 has been selected. Temperature reference if 3 has been selected).	o17	Display mode
Manual control of outputs For service purposes the individual relay outputs and the ETS-output can be forced. However only when regulation has been stopped. OFF: No override. 3: Alarm relay is activated (connection established between terminals 12 and 13). After 600 seconds the manual control will be interrupted, and the setting will return to "0". In settings 3, "o45" will become active and the ETS output can be set manually.	o18	Manual ctrl
Manual control of the ETS valve When "o18" is activated the valve's opening degre can be determined from this menu.	o45	Manual ETS OD%
Working range for pressure transmitter Depending on the application a pressure transmitter with a given working range is used. This working range (say, -1 – 12 bar) must be set in the controller. The min. value is set.	o20	MinTransPres.
The max. value is set	o21	MaxTransPres.
Selection of control mode (loop Ctrl) Depending on the application control can be carried out based on different parameters. The two possibilities are shown in appendix 4. 1=normal control 2=double loop The initial or factory setting for Loop Ctrl (o56) is 1, and factory settings for Kp factor (n04) is 3.0 and KpTo (n20) is 0.4. When Loop Ctrl. is set for 2, Kp factor and KpTo will be initially set to 0.7 and 3.0 respectively. Changes can still be made to these parameters when Loop Ctrl is changed. When Loop Ctrl is set to 1, Kp factor and KpTo are set to factory settings. Note, Loop Ctrl. can only be changed when Main Switch (r12) is off.	o56	Loop ctrl

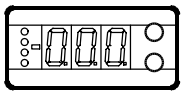
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Survey of functions

Function	Parameter	Parameter by operation via data communication
Refrigerant setting Before refrigeration can be started, the refrigerant must be defined. You can select the following refrigerants: 1=R12. 2=R22. 3=R134a. 4=R502. 5=R717. 6=R13. 7=R13b1. 8=R23. 9=R500. 10=R503. 11=R114. 12=R142b. 13=User defined. 14=R32. 15=R227. 16=R401A. 17=R507. 18=R402A. 19=R404A. 20=R407C. 21=R407A. 22=R407B. 23=R410A. 24=R170. 25=R290. 26=R600. 27=R600a. 28=R744. 29=R1270. (Warning: Wrong selection of refrigerant may cause damage to the compressor).	o30	Refrigerant
Service		**Service**
A number of controller values can be printed for use in a service situation.		
Read status of input DI (start/stop input).	u10	DI
Read the temperature at the S2 sensor.	u20	S2 temp.
Read superheat.	u21	SH
Read the control's actual superheat reference.	u22	SH ref.
Read the valve's opening degree.	u24	OD%
Read evaporating pressure.	u25	Evap. pres. Pe
Read evaporating temperature.	u26	Evap.Press.Te
Read the temperature at the S4 sensor.	u27	S4 temp.
Read value of current signal from pressure transmitter (AIB).	u29	AI B mA
	--	DO1 Alarm Read status of alarm relay
For Danfoss only		
Start-up time for safety signal If the controller does not obtain a reliable signal within this period of time the con-troller will in other ways try to establish a stable signal. (A too high value may result in a flooded eaporator). The value should only be changed by specially trained staff.	n15	StartUp time
Signal safety during start-up The control function uses the value as start value for the valve's opening degree at each thermostat cutin. By adaptive control the controller continuously calculates a new value. The value should only be changed by specially trained staff.	n17	Start OD%
Operating status		
The controller's operating status can be called forth by a brief (1s) activation of the upper button. If a status code exists it will be shown. (Status codes have lower priority than alarm codes. This means that status codes cannot be seen if there is an active alarm code. The status code have the following meaning:		EKC State (0 = regulation)
S10: Refrigeration stopped by the internal or external start/ stop.		10
S26: No refrigerant selected.		26

Operation

Display
The values will be shown with three digits, and with a setting you can determine whether the temperature are to be shown in °C or in °F. (Pressure in bar or psig.)



Light-emitting diodes (LED) on front panel
There are LED's on the front panel which will light up when the belonging relay is activated.
The uppermost LED will indicate when the valve is moving towards a greater opening degree.
The next LED will indicate when the valve is moving towards a smaller opening degree.
All light-emitting diodes will flash when there is an error in the regulation.
In this situation you can upload the error code on the display and cancel the alarm by giving the uppermost button a brief push.

The buttons
When you want to change a setting, the two buttons will give you a higher or lower value depending on the button you are pushing. But before you change the value, you must have access to the menu. You obtain this by pushing the upper button for a couple of seconds - you will then enter the column with parameter codes. Find the parameter code you want to change and push the two buttons simultaneously. When you have changed the value, save the new value by once more pushing the two buttons simultaneously.



Gives access to the menu (or cutout an alarm)

Gives access to changes

Saves a change

Examples of operations
Set one of the other menus

1. Push the upper button until a parameter is shown
2. Push one of the buttons and find the parameter you want to change
3. Push both buttons simultaneously until the parameter value is shown
4. Push one of the buttons and select the new value
5. Push both buttons again to conclude the setting

Menu survey

SW =1.2x

Function	Param.	Min.	Max.	Fac. setting
Normal display				
Shows the actual superheat/ valve's opening degree/ temperature. Define view in o17	-	K		
If you wish to see the expansion valve's actual opening degree, give the lower button a brief push (1s). Define view in o17	-	%		
Reference				
Units (0=°C+bar / 1=°F+psig)	r05	0	1	0
Start/stop of refrigeration	r12	OFF	On	1
Regulating parameters				
P: Amplification factor Kp	n04	0.5	20	3
I: Integration time T	n05	30 s	600 s	120
Max. value of superheat reference	n09	2 K	30 K	10
Min. value of superheat reference	n10	1 K	12 K	4
MOP	n11	0.0 bar	20 bar	20
Signal reliability during start-up. Safety time period. Should only be changed by trained staff.	n15	0 s	90 s	0
Signal reliability during start-up – Opening degree's start value. Should only be changed by trained staff	n17	0%	100%	0
Amplification factor for superheat Changes should only be made by trained staff	n20	0.0	10.0	0,4
Value of min. superheat reference for loads under 10%	n22	1 K	15 K	2
"n37" and "n38" are adapted to valve type ETS 50 and should only be changed through the use of another valve				
Number of steps from 0-100% opening degree (x10) (ETS 50=263, ETS 100=353) ETS 12.5, ETS 25, ETS 50=263 ETS 100=353 ETS 250, ETS 400=381	n37	000 stp*	5000 stp *	263
Number of steps per second	n38	10 stp/s	300 stp/s	250
Integration time for inner loop (TnT0)	n44	10 s	120 s	30
Miscellaneous				
Controller's address	o03 *)	1	60	
ON/OFF switch (service-pin message)	o04 *)	-	-	
Set supply voltage frequency	o12	50 Hz	60 Hz	50
Select display for "normal picture" 1: Superheat 2: Valve's opening degree 3: Air temperature	o17	1	3	1
Manual control of outputs: OFF: no manual control 3: Alarm relay activated (cut out) At settings 3, "o45" will be active	o18	off	3	0
Working range for pressure transmitter – min. value	o20	-1 bar	60 bar	-1.0
Working range for pressure transmitter – max. value	o21	-1 bar	60 bar	12
Refrigerant setting 1=R12. 2=R22. 3=R134a. 4=R502. 5=R717. 6=R13. 7=R13b1. 8=R23. 9=R500. 10=R503. 11=R114. 12=R142b. 13=User defined. 14=R32. 15=R227. 16=R401A. 17=R507. 18=R402A. 19=R404A. 20=R407C. 21=R407A. 22=R407B. 23=R410A. 24=R170. 25=R290. 26=R600. 27=R600a. 28=R744. 29=R1270.	o30	0	29	0

**) The display on the controller can show 3 digits only, but the setting value has 4 digits. Only the 3 most important will be shown. It means f.ex. . 250 will give a setting of 2500.*

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Menu survey

Function	Param.	Min.	Max.	Fac. setting
Manual control of the valve's opening degree. The function can only be operated if "o18" has been set	o45	0 %	100 %	0
Selection of loop ctrl: 1=Normal 2=double loop	o56	1	2	1

Service

Read status of input DI	u10	on/off
Temperature at S2 sensor	u20	°C
Superheat	u21	K
Superheat reference	u22	K
Read AKV valve's opening degree	u24	%
Read evaporating pressure	u25	bar
Read evaporating temperature	u26	°C
Temperature at S4 sensor	u27	°C
Read signal at pressure transmitter input	u29	mA

**) This setting will only be possible if a data communication module has been installed in the controller.*

The controller can give the following messages

E1	**Error message**	Fault in controller
E15		Cut-out S2 sensor
E16		Shortcircuited S2 sensor
E17		Cut-out S4 sensor
E18		Shortcircuited S4 sensor
E20		The input signal on terminals 14-15 is outside the range (P0 signal)
A11	**Alarm message**	No refrigerant has been selected
A43		Check the supply voltage to the step motor

Operating status		(Measurement)
The controller goes through some regulating situations where it is just waiting for the next point of the regulation. To make these "why is nothing happening" situations visible, you can see an operating status on the display. Push briefly (1 s) the upper button. If there is a status code, it will be shown on the display. The individual status codes have the following meanings.		Ctrl. state: (Shown in all menu displays)
Normal regulation	S0	0
Refrigeration stopped by main switch. Either with r12 or a DI-input	S10	10
No refrigerant selected	S26	26

Factory setting
If you need to return to the factory-set values, it can be done in this way:
- Cut out the supply voltage to the controller
- Keep both buttons depressed at the same time as you reconnect the supply voltage

Installation considerations

Accidental damage, poor installation, or site conditions, can give rise to malfunctions of the control system, and ultimately lead to a plant breakdown.
Every possible safeguard is incorporated into our products to prevent this. However, a wrong installation, for example, could still present problems. Electronic controls are no substitute for normal, good engineering practice.

Danfoss wil not be responsible for any goods, or plant components, damaged as a result of the above defects. It is the installer's responsibility to check the installation thoroughly, and to fit the necessary safety devices.
Particular attention is drawn to the need for a "force closing" signal to controllers in the event of compressor stoppage, and to the requirement for suction line accumulators.

Your local Danfoss agent will be pleased to assist with further advice, etc.

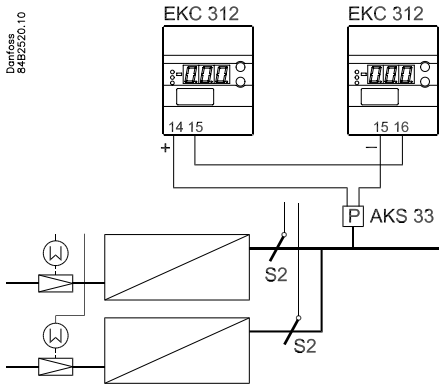
Appendix 1

Interaction between internal and external start/stop functions and active functions.

Internal Start/stop	Off	Off	On	On
External Start/stop (DI)	Off	On	Off	On
Refrigeration (DO2)	Off			On
Sensor monitoring	Yes			Yes

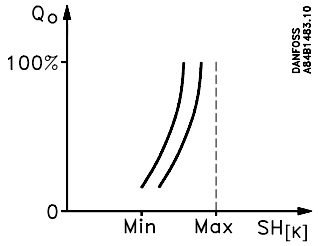
Appendix 2

If there are two evaporators sharing the same suction line, the signal from the pressure transmitter can be used by two controllers.



Appendix 3

Adaptive superheat



Regulation is here based on the evaporator's load by means of MSS search (MSS = lowest permissible superheat).
(The superheat reference is lowered to the exact point where instability sets in).
The superheat is limited by the settings for min.and max. superheat.

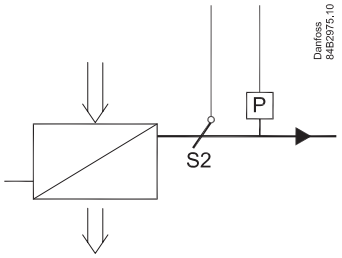
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Appendix 4

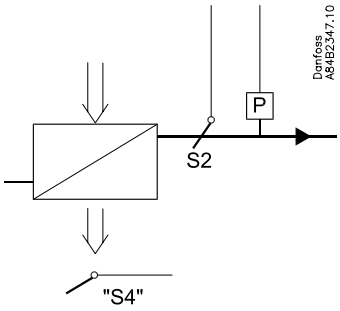
Regulation algorithms for the superheat. (loop ctrl.).

There are two algorithms to choose between.
They are set in "o56".

Loop Ctrl.=1
This regulation algorithm is used for the classical method and is recommended for known applications – e.g. for earlier installations with a Danfoss controller. For a start the values for Kp, and Tn can be set to values corresponding to the earlier ones.



Loop Ctrl. =2
This setting is recommended if only one regulation of the superheat is required.
The regulation algorithm necessitates the mounting of a temperature sensor in the media.



The S4 and T0 temperatures also form part of an inner loop regulation.

Start of controller

When the electric wires have been connected to the controller, the following points have to be attended to before the regulation starts:
1. Switch off the external ON/OFF switch that starts and stops the regulation
2. Follow the menu survey on page 6, and set the various para-meters to the required values
3. Switch on the external switch, and regulation will start
4. Follow the actual superheat on the display

If the superheating fluctuates

When the refrigerating system has been made to work steadily, the controller's factory-set control parameters should in most cases provide a stable and relatively fast regulating system.
If the system however fluctuates this may be due to the fact that too low superheat parameters have been selected:

Adjust: n09 and n10.

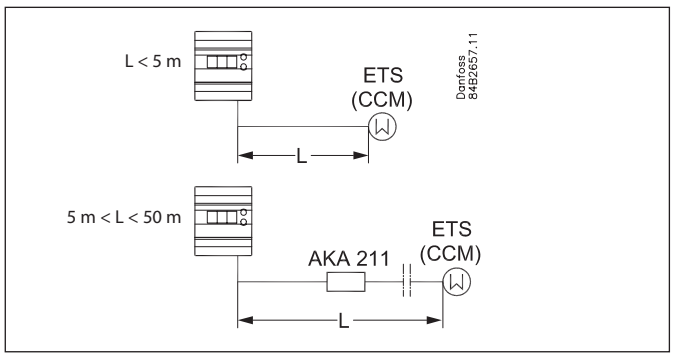
Alternatively it may be due to the fact that the set regulation parameters are not optimal.

If the time of oscillation is longer than the integration time:
($T_p > T_n$, (T_n is, say, 240 seconds))
1. Increase T_n to 1.2 times T_p
2. Wait until the system is in balance again
3. If there is still oscillation, reduce K_p by, say, 20%
4. Wait until the system is in balance
5. If it continues to oscillate, repeat 3 and 4

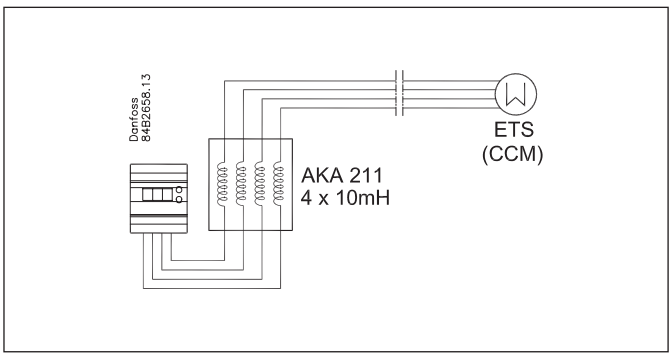
If the time of oscillation is shorter than the integration time:
($T_p < T_n$, (T_n is, say, 240 seconds)).
1. Reduce K_p by, say, 20% of the scale reading.
2. Wait until the system is in balance.
3. If it continues to oscillate, repeat 1 and 2.

ETS connection

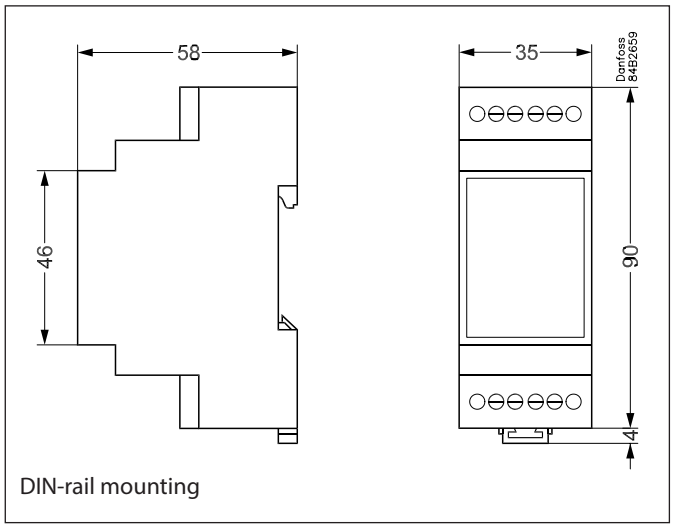
If the distance between EKC 312 and the ETS valve exceeds 5 m a filter must be mounted to obtain the correct valve function.
The filter must be placed close to EKC 312.



Connection



Dimensions



DIN-rail mounting

Ordering

Type	Description	Code no.
AKA 211	Filter 4 × 10 mH	084B2238

List of literature

Instructions:
RI8JZ (extract from this manual).
Here you can see how controllers are mounted and programmed.

Installation guide for extended operation RC8AC
Here you can see how a data communication connection to ADAP-KOOL® Refrigeration control systems can be established.

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