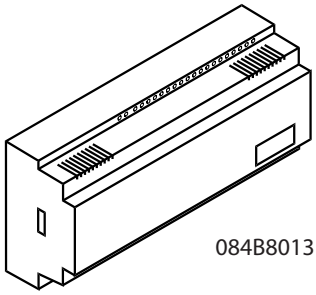
REFRIGERATION AND AIR CONDITIONING

# Instructions
## AK-PC 560

084R8036

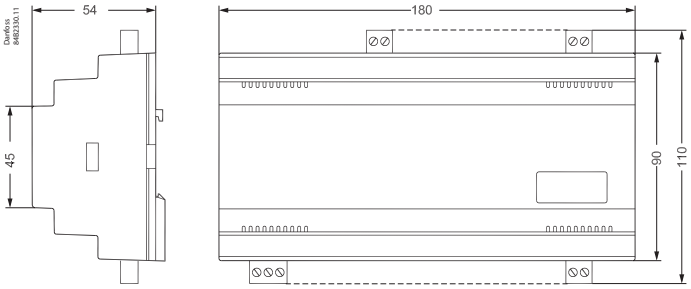
RI8PM102

### Identification

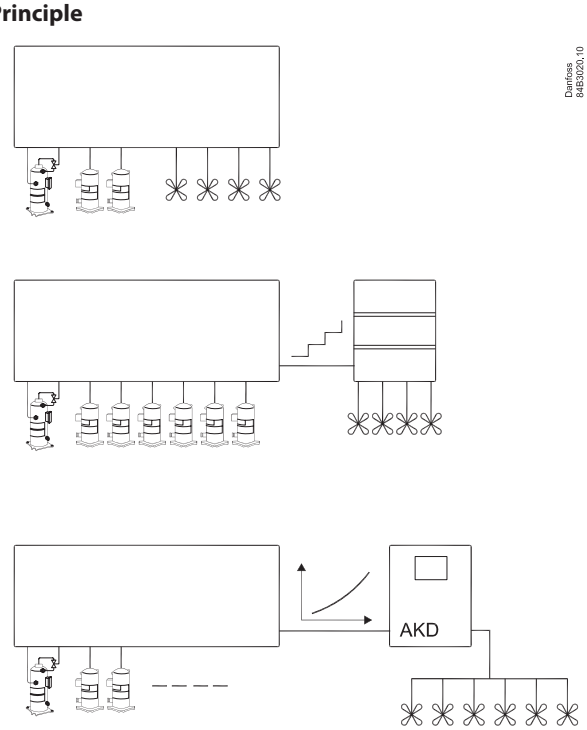


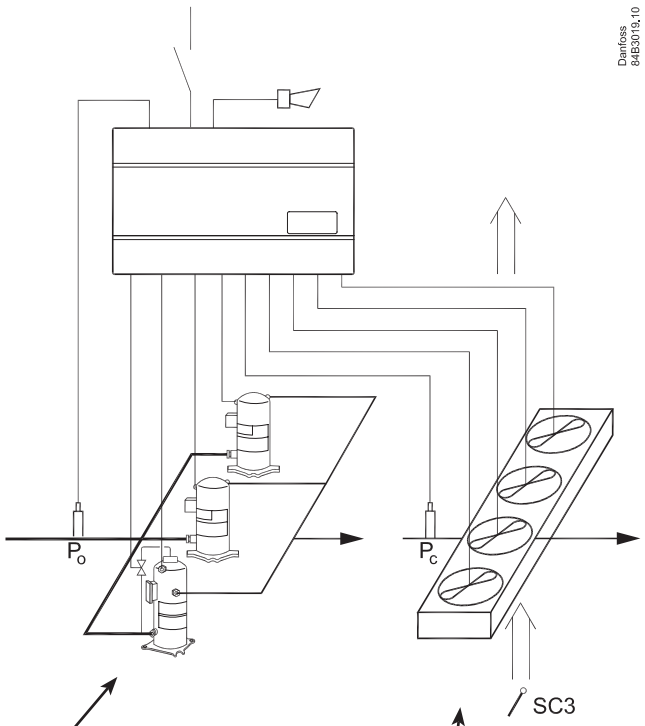
084B8013

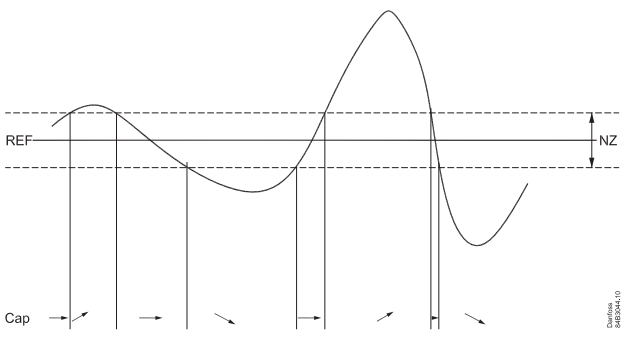
### Dimensions



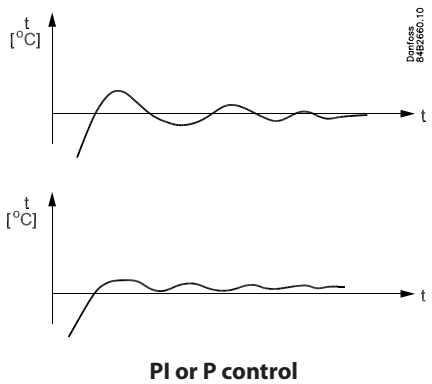

### Principle



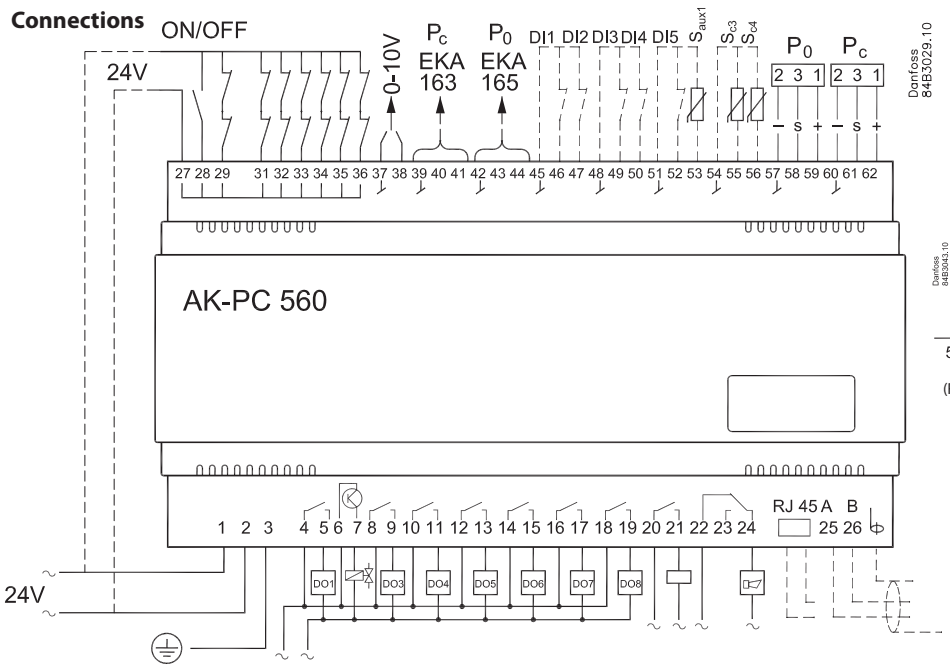



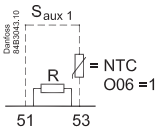

NZ control



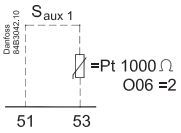

PI or P control

**Connections**




(R=1680 ohm)




P0/Pc: AKS 32R:
1 = Black = +
2 = Blue = -
3 = Brown = s

All inputs are low-voltage.
Relay output 1-8 are low voltage.
Relay output 9 and 10 may be high voltage.

Data communication

**Necessary connections**

Terminals:

1-2 Supply voltage 24 V a.c.
4-5 Relay outputs for digital scroll compressor
6-7 Solid state relay for digital scroll compressor's unloader
8- 19 Relay outputs for either compressors or fan motors
22-24 Alarm relay *
There is connection between 22 and 24 in alarm situations and when the controller is dead

27-28 4 V signal to start / stop of regulation
27-29 24 V signal from the safety circuit Digital scroll
30 No function
27-31 24 V signal from the safety circuit DO 3
27-32 24 V signal from the safety circuit DO 4
27-33 24 V signal from the safety circuit DO 5
27-34 24 V signal from the safety circuit DO 6
27-35 24 V signal from the safety circuit DO 7
27-36 24 V signal from the safety circuit DO 8
57-59 Suction pressure. Voltage signal from AKS 32R **
60-62 Condenser pressure. Voltage signal from AKS 32R **

**Application dependent connections**

20-21 AKD start/stop *
The relay cutin when the frequency converter have to start.
37-38 Voltage signal to external condenser control
(see settings page 12)
39-41 Possibility of connecting an external display type EKA 163 or display of Pc
42-44 Possibility of connecting an external display type EKA 163 for display of P0, or EKA 165 for operation and display of P0
45-46 DI1 - Contact function for alarm signal
45-47 DI2 - Contact function for alarm signal
48-49 DI3 - Contact function for alarm signal
48-50 DI4 - Contact function for displacement of the suction pressure reference or for alarm signal.
51-52 DI5 - Contact function for displacement of the condenser pressure reference or for alarm signal.
51-53 Separate sensor Saux. Discharge gas temperature. Sensor signal from Pt 1000 (AKS 21) or Copeland-NTC and with supplied resistor mounted.
54-55 Outdoor ambient temperature (Sc3). Sensor signal from Pt 1000, AKS 11 or AKS 21 (mounted if r33 = 2 or 4).
54-56 Air temperature at condenser outlet. Sensor signal from a Pt 1000, AKS 11 or AKS 21.

**Data communication**

25-26 Mount only, if a data communication module has been fitted.
For ethernet communication the plug connection RJ45 must be used. (LON FTT10 can also be connected in this way.
It is <u>important</u> that the installation of the data communication cable be done correctly. Cf. separate literature No. RC8AC.

*)
Relays DO9 and DO10 may in special cases be reconfigurated so that they can be used as fan relays.

**)
If the controller has to control only the compressor or the fans, respectively Pc and P0 sensor can be dispensed

**Compressor configuration when o61 =1 or 2** (This is where you can choose between the options shown.)
Setting "c16" will define the configuration.
Setting "c08" will define coupling mode.

| Compressor connections | | | | | | | | Coupling mode |
|---|---|---|---|---|---|---|---|---|
| Relay no. | | | | | | | | Set **"c16"** to | Set **"c08"** to |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| 1 | | | | | | | | 1 | - |
| 1 | | 2 | | | | | | 2 | - |
| 1 | | 2 | 3 | | | | | 3 | 1 / 2 |
| 1 | | 2 | 3 | 4 | | | | 4 | 1 / 2 |
| 1 | | 2 | 3 | 4 | 5 | | | 5 | 1 / 2 |
| 1 | | 2 | 3 | 4 | 5 | 6 | | 6 | 1 / 2 |
| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 1 / 2 |

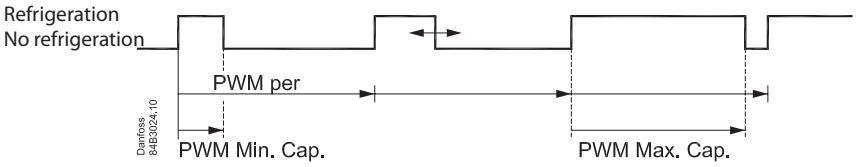
Danfoss 84EB3031.10

**Capacity step**
**All** capacity steps are presumed to be identical.

**Coupling mode**
Coupling mode 1 = *sequential* operation.
Compressor 1 will be the first to start. Then compressor 2 and so on.
Coupling mode 2 = *cyclic* operation.
Compressor 1 will always be in operation when cooling is required. After this the compressor with the lowest number of operating hours will be started.

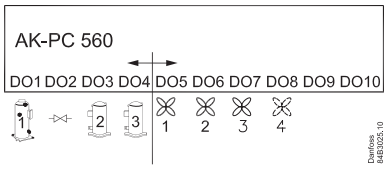
**The capacity from the digital scroll compressor**

The capacity is divided into period times as "PWM per". 100% capacity is delivered when cooling takes place for the whole period. An off time is required by the by-pass valve within the period and an on time is also permitted. There is "no cooling" when the valve is on.
The controller itself calculates the capacity needed and will then vary it according to the cut-in time of the by-pass valve.
A limit is introduced if low capacity is needed so that the cooling does not go below 10%. This is because the compressor can cool itself. This value can be increased if necessary.
The capacity can similarly be limited so that the compressor cannot deliver 100% capacity. It is not normally necessary to limit this max. capacity.

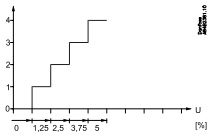


**Condenser couplings**

When the compressor relays have been established the turn comes to the fan relays.
The first vacant relay (DO3-DO8) will become the first fan relay.
It will be followed by the subsequent relays. If more relays are required than the vacant DO relays, a relay module can be connected to the analog output. The function is, as follows:

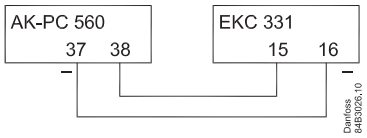



If there are up to four external fans on an EKC 331:

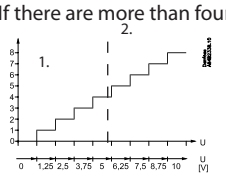



Output signal from AK-PC 560
In EKC 331 the voltage range must be set to 0-5 V ("o10" = 6).
In EKC 331 the number of steps must be set **to 4 ("o19" = 4)** (also when fewer fans are connected).

Connection

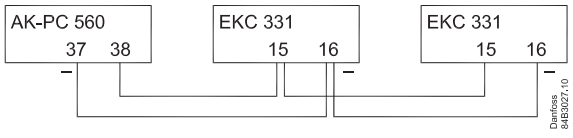



If there are more than four external fans on two EKC 331 units:

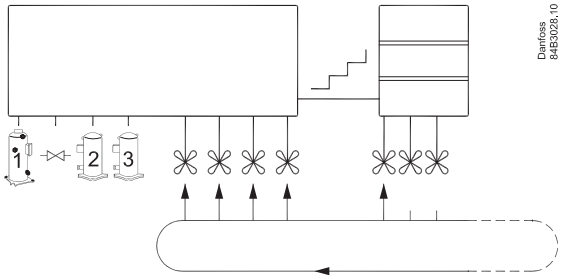



Output signal from AK-PC 560
In the first EKC 331, set 0-5 V ("o10" = 6).
In the second EKC 331, set 5-10 V ("o10" = 7).
In **both** EKC's the number of steps must be set **to 4 ("o19" = 4)** (also when fewer fans are connected to the second EKC).

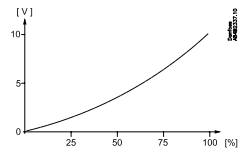
Connection




Alternating start-up of fans (only if c29 is 11 to 18)
The fans can be defined to start alternately when they have all been stopped.
The first time regulation is started, fan 1 will be started first – the regulation determines whether additional fans will be started.
After the next time all fans are stopped, fan 2 will be the first to be started, and so on.
Fan 1 will again be the first fan to be started when the rotation has been through the total number of fans.
If there is more than one fan on an EKC 331, it will not be possible to start the other fans first. Here, the fan with the lowest voltage step will always be the one which is started first.




If the entire condenser capacity is to be controlled by a frequency converter, AK-PC 560 must send an analog signal about the required capacity ("c29" = 9).
The signal varies from 0 to 10 V. Signal and capacity have the following context.

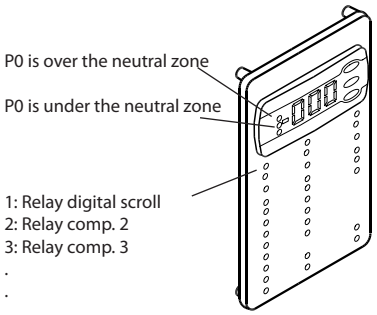


# Operation

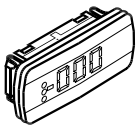
**Data communication**
If the controller is extended with data communication, the operation can be performed from a system unit.

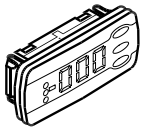
The importance of the alarms that are sent can be defined with the setting: 1 (High), 2 (Medium), 3 (Low) or 0 (No alarm).

**Operation via external display**
The values will be shown with three digits, and with a setting you can determine whether the pressures are to be shown in SI units (°C / bar) or US units (°F / psig.).
There are three options for the display.



EKA 165


EKA 163


EKA 164

**EKA 165**
To operate the controller and view the evaporation pressure.
If the lowermost key is pressed, the condensation pressure will be shown briefly in the display. (If regulation is based only on the condensation pressure, the display will always show Pc).

During normal operation the light-emitting diodes in the display will indicate where regulation is taking place.

| | | |
|---|---|---|
| Second highest | : | Over neutral zone |
| "None" | : | Neutral zone |
| Second lowest | : | Under neutral zone |

The other LEDs on the display will show the functions that are active:
- Relays for compressors
- The capacity can be read from the digital scroll compressor
- Relays for fans
- Input signals for the digital inputs
  - The optimization LED will light up when the reference is 2 K or more over the set point.

**EKA 163**
If the condensation pressure is to be shown constantly, a display without operating keys can be connected.

**EKA 164**
To operate the controller and view the evaporation pressure.
If the lowermost key is pressed, the condensation pressure will be shown briefly in the display.
Like the EKA 165, the LEDs in the display will show where the regulation is located.

The buttons on the display
When you want to change a setting, the upper and the lower 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 middle button. When you have changed the value, save the new value by once more pushing the middle button.

Or short:
1. Push the upper button (long push) until a parameter is shown
2. Push one of the buttons and find the parameter you want to change
3. Push the middle button until the setting value is shown
4. Push one of the buttons and select the new value
5. Push the middle button again to conclude the setting

( A brief pushing will show the active alarm codes.)

# Menu survey

**Sequence**

**1.** o61 **must** be set as the first parameter. This parameter determines which of the four operating interfaces (application mode) are activated. This **must** be set via the display keys. It cannot be set via data communication. (Active functions are shown below in shaded fields.)

**2.** Quick- start
To get the system up and running quickly so that cooling can be commenced, start it by setting the following parameters (these parameters can only be set when the regulation is stopped, r12=0): r23, r28, c08, c16, c29, o06, o30, o75, o76 **and finally r12=1**.

**3.** Once the regulation is under way, you can go through the other parameters and adjust them in situ.

SW: 1.0x

| Function | Parameter | o61 = 1 | o61 = 2 | Min. | Max. | Factory setting |
|---|---|---|---|---|---|---|
| **Normal display** | | | | | | |
| Shows P0 in EKA 165 (display with buttons) | - | °C | P | | °C / bar | |
| Shows Pc in EKA 163 | - | °C | P | | °C / bar | |
| **P0 reference** | | | | | | |
| Neutral zone | r01 | | | 0.1°C / 0.1 bar | 20°C /5.0 bar | 4.0°C / 0.4 bar |
| Correction of signal from P0 sensor | r04 | | | -50°C /-5.0 bar | 50°C / 5.0 bar | 0.0 |
| Select view; SI or US. 0=SI (bar /°C), 1=US (Psig /°F) | r05 | | | 0 | 1 | 0 |
| Start/Stop of regulation | r12 | | | OFF | ON | OFF |
| Reference offset for P0 (see also r27) | r13 | | | -50°C / -5.0 bar | 50°C / 5.0 bar | 0.0 |
| Set regulation set point for P0 | r23 | | | -99°C / -1 bar | 30°C / 60.0 bar | 0.0°C / 3.5 bar |
| Shows total P0 reference ( r23 + various displacements) | r24 | | | | °C / bar | |
| Limitation: P0 reference max. value (also applies to regulation with reference displacement) | r25 | | | -99°C / -1.0 bar | 30°C / 60.0 bar | 30.0°C / 40.0 bar |
| Limitation: P0 reference min. value (also applies to regulation with reference displacement) | r26 | | | -99°C / -1.0 bar | 30°C / 40.0 bar | -99.9°C / -1.0 bar |
| Displacement of P0 (ON=active "r13") | r27 | | | OFF | ON | OFF |
| **Pc reference** | | | | | | |
| Set regulation set point for Pc | r28 | | | -25°C / 0.0 bar | 75°C / 110.0 bar | 35°C / 15.0 bar |
| Shows total Pc reference | r29 | | | | °C / bar | |
| Limitation: Pc reference max. value | r30 | | | -99.9°C / -0.0 bar | 99.9°C/ 130.0bar | 55.0°C / 60.0 bar |
| Limitation: Pc reference min. value | r31 | | | -99.9°C / 0.0 bar | 99.9°C / 60.0 bar | -99.9°C / 0.0 bar |
| Correction of signal from Pc sensor | r32 | | | -50°C / -5.0 bar | 50°C / 5.0 bar | 0.0 |
| Pc reference variation. 1 and 2 are PI-regulation<br>1: Fixed reference. "r28" is used<br>2: Variable reference. Outdoor temperature (Sc3) included in the reference<br>3: As 1, but with P-regulation (Xp-band)<br>4: As 2, but with P-regulation (Xp-band) | r33 | | | 1 | 4 | 1 |
| Reference offset for Pc | r34 | | | -50°C / -5.0 bar | 50°C / 5.0 bar | 0.0 |
| The mean temperature difference across the condenser at maximum load (dim tm K) | r35 | | | 3.0 | 50.0 | 10.0 |
| The mean temperature difference across the condenser at the lowest relevant compressor capacity (min tm K) | r56 | | | 3.0 | 50.0 | 8.0 |
| **Capacity** | | | | | | |
| Min. ON time for relays | c01 | | | 0 min | 30 min. | 0 |
| Min. time period between cutins of same relay | c07 | | | 2 min. | 60 min | 2 |
| Definition of regulation mode<br>1: Sequential (step mode / FILO)<br>2: Cyclic (step mode / FIFO) | c08 | | | 1 | 2 | 1 |
| Definition of compressor connections.<br>See options on page 3. | c16 | | | 1 | 7 | 1 |
| Definition of condenser:<br>**1-8:** Total number of fan relays or voltage step on the voltage output<br>**9:** Only via analog output and start of frequency converter<br>**10:** Not used<br>**11- 18:** Total number of fan relays which are to be connected with alternating start-up. | c29 | | | 0/OFF | 18 | 0 |
| Cut in compressor capacity with manual control. See also "c32" | c31 | | | 0% | 100% | 0 |
| Manual control of compressor capacity (when ON, the value in "c31" will be used) | c32 | | | OFF (0) | ON (1) | OFF (0) |

To be continued

| | | | | | | |
|---|---|---|---|---|---|---|
| Pump down limit. Limit value where the last compressor is cut out. | c33 | | | -99.9°C / -1.0 bar | 100°C / 60 bar | 100°C / 60 bar |
| Time delay for incorrect cut-out, compressor 1 | c77 | | | 0 s | 240 s | 60 s |
| Time delay for incorrect cut-out, compressor x; x=2, 3 and so on. | c78 | | | 0 s | 240 s | 60 s |
| Pulse width period for the digital scroll modulation | c79 | | | 10 s | 30 s | 20 s |
| Max. capacity in the pulse width period | c80 | | | 50 % | 100 % | 100 % |
| Min. capacity in the pulse width period | c81 | | | 10 % | 50 % | 10 % |
| Kp factor for PI regulation of the digital scroll | c82 | | | 2 | 20 | 5 |
| Tn factor for PI regulation of the digital scroll | c83 | | | 40 s | 300 s | 50 s |
| The digital scroll's capacity compared to one of the other compressors | c84 | | | 100% | 200% | 100% |
| Proportional band Xp for (P= 100/Xp) condenser regulation | n04 | | | 0.2 K / 0.2 bar | 40.0 K / 10.0 bar | 10.0 K / 3.0 bar |
| I: Integration time Tn for condenser regulation | n05 | | | 30 s | 600 s | 150 |
| Cutin condenser capacity with manual control. See also "n53" | n52 | | | 0% | 100% | 0 |
| Manual control of condenser capacity (when ON, the value in "n52" will be used) | n53 | | | OFF (0) | ON (1) | OFF (0) |
| Start speed The voltage for the speed regulation is kept at 0V until the regulation requires a higher value than the value set here. | n54 | | | 0% | 75% | 20% |
| Min. speed. The voltage for the speed regulation switches to 0V when the regulation requires a lower value than the value set here. | n55 | | | 0% | 50% | 10% |
| **Alarm** | | | | | | |
| Delay time for a A32 alarm | A03 | | | 0 min. | 90 min. | 0 min. |
| Low alarm and safety limit for P0 | A11 | | | -99°C / -1.0 bar | 30°C / 40 bar | -40°C / 0.5 bar |
| Delay time for a DI1 alarm | A27 | | | 0 min. (-1=OFF) | 480 min. | OFF |
| Delay time for a DI2 alarm | A28 | | | 0 min. (-1=OFF) | 480 min. | OFF |
| Delay time for a DI3 alarm | A29 | | | 0 min. (-1=OFF) | 480 min. | OFF |
| Upper alarm and safety limit for Pc | A30 | | | -10 °C / 0.0 bar | 200°C/200 bar | 60.0°C / 60.0 bar |
| Upper alarm limit for sensor "Saux1" If a higher value is measured then the digital scroll stops. | A32 | | | 1°C (0=OFF) | 150°C | 130°C |
| Delay time for a P0 alarm | A44 | | | 0 min. (-1=OFF) | 480 min. | 0 min. |
| Delay time for a Pc alarm | A45 | | | 0 min. (-1=OFF) | 480 min. | 0 min. |
| **Miscellaneous** | | | | | | |
| Controllers address | o03* | | | 1 | 240 | |
| On/off switch (service-pin message) | o04* | | | - | - | |
| Access code | o05 | | | 1 (0=OFF) | 100 | OFF |
| Used sensor type for Saux<br>**1**=Internal Copeland NTC. (A fixed resistor must also be fitted.)<br>**2**=Pt 1000 | o06 | | | 1 | 2 | 1 |
| Set supply voltage frequency | o12 | | | 50 Hz (0) | 60 H (1) | 50Hz (0) |
| Manual control of outputs:<br>**0:** No override<br>**1-10:** 1 will cut in relay 1, 2 relay 2, etc.<br>**11-18:** Gives voltage signal on the analog output. (11 gives 1.25 V, and so on in steps of 1.25 V | o18 | | | 0 | 18 | 0 |
| P0 pressure transmitter's working range - min. value | o20 | | | -1 bar | 5 bar | -1.0 |
| P0 pressure transmitter's working range - max. value | o21 | | | 6 bar | 199 bar | 12.0 |
| Use of DI4-input<br>**0=**not used. **1=**P0 displacement. **2=**alarm function. Alarm="A31" | o22 | | | 0 | 2 | 0 |
| Operating hours of relay 1 (value time 1000) | o23 | | | 0.0 h | 99.9 h | 0.0 |
| Operating hours of relay 3 (value time 1000) | o25 | | | 0.0 h | 99.9 h | 0.0 |
| Operating hours of relay 4 (value time 1000 | o26 | | | 0.0 h | 99.9 h | 0.0 |
| Setting of refrigerant<br>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. 30=R417A. 31=R422A. 32=R413A. 33=R422D. 34=R427A. 35=R438A. 36=XP10. 37=R407F | o30 | | | 0 | 37 | 0 |
| Use of DI5-input<br>**0=**not used. **1=**Pc displacement. **2=**alarm function. Alarm="A32" | o37 | | | 0 | 2 | 0 |
| Pc pressure transmitter's working range - min. value | o47 | | | -1 bar | 5 bar | -1.0 |
| Pc pressure transmitter's working range - max. value | o48 | | | 6 bar | 199 bar | 34.0 |
| Operating hours of relay 5 (value time 1000) | o50 | | | 0.0 h | 99.9 h | 0.0 |
| Operating hours of relay 6 (value time 1000) | o51 | | | 0.0 h | 99.9 h | 0.0 |
| Operating hours of relay 7 (value time 1000) | o52 | | | 0.0 h | 99.9 h | 0.0 |

* this setting is only possible if data communication module is mounted in the controller

| | | | | | | |
|---|---|---|---|---|---|---|
| Operating hours of relay 8 (value time 1000) | o53 | | | 0.0 h | 99.9 h | 0.0 |
| Selection of application<br>1. Show temperature and "c16" mode<br>2: Show pressure and "c16" mode | o61 | 1 | 2 | 1 | 2 | 1 |
| Function for relay output DO9:<br>0. Start / stop of speed regulation<br>1. Inject on signal for evaporator control<br>2. Boost ready (at least one compressor is on)<br>3. Start /stop of condenser fan | o75 | | | 0 | 3 | 0 |
| Function for relay output DO10:<br>0. Alarm relay<br>1. Start / stop of condenser fan | o76 | | | 0 | 1 | 0 |
| Definition of alarm message at DI1 signal:<br>0. Not used<br>1. Fan failure (A34)<br>2. DI1 alarm (A28) | o78 | | | 0 | 2 | 0 |
| Display connection<br>Off: EKA 164<br>On: EKA 165 (extended display with light-emitting diodes) | o82 | | | Off | On | Off |
| **Service** | | | | | | |
| Temperature at Saux (discharge gas temperature) | u03 | | | | | |
| Status on DI1 input | u10 | | | | | |
| Status on DI2 input | u37 | | | | | |
| Read temperature at sensor "Sc3" | u44 | | | | | °C |
| Read temperature at sensor "Sc4" | u45 | | | | | °C |
| Status on DI3 input | u87 | | | | | |
| Status on DI4 input | u88 | | | | | |
| Status on DI5 input | u89 | | | | | |
| Read regulation capacity in % of the digital scroll | U28 | | | | | |

| The controller can give the following messages | | | |
|---|---|---|---|
| E1 | **Error message** | Fault in controller | |
| E2 | | Regulation is outside the range, or the control signal is defective | |
| A2 | **Alarm message** | Low P0 | |
| A11 | | Refrigerant not selected | |
| A17 | | High Pc | |
| A19 | | Compressor 1 error (29) | The actual compressors safety circuit is interrupted. That is to say the signal is missing on one of the terminals 29-36 |
| A20 | | Compressor 2 error (31) | |
| A21 | | Compressor 3 error (32) | |
| A22 | | Compressor 4 error (33) | |
| A23 | | Compressor 5 error (34) | |
| A24 | | Compressor 6 error (35) | |
| A25 | | Compressor 7 error (36) | |
| A27 | | Saux discharge gas temperature to high . Digital scroll is stopped | |
| A28 | | DI 1 alarm. Terminal 46 interrupted | |
| A29 | | DI 2 alarm. Terminal 47 interrupted | |
| A30 | | DI 3 alarm. Terminal 49 interrupted | |
| A31 | | DI 4 alarm. Terminal 50 interrupted | |
| A32 | | DI 5 alarm. Terminal 52 interrupted | |
| A34 | | Fan alarm. There is no signal on DI1 input | |
| A45 | | Regulation stopped | |
| S0 | **Status message** | Regulation | |
| S2 | | Wait for "c01" | |
| S5 | | Wait for "c07" | |
| S10 | | Refrigeration stopped by the internal or external start/stop function | |
| S25 | | Manual control of outputs | |
| S34 | | Safety cutout. Setting A30 is exceeded or all safety inputs (29-36) are open | |
| PS | **Info** | Access code is required before you have access to the settings | |

Messages can be brought up on the display by briefly pressing the uppermost key. If there is more than one alarm, they can be scrolled through

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 the middle button pressed at the same time as you reconnect the supply voltage

FC-SPMC