

**COMPRESSOR PAK WITH DAMPER CONTROL  
SOFTWARE VERSION 5.XX**

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SK339	COMPRESSOR PAK CONDENSER CONTROL
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NOTE: NOT UNDER DOCUMENTATION CONTROL

# COMPRESSOR PAK WITH DAMPER CONTROL SOFTWARE VERSION 5.XX

## 1 INTRODUCTION

Compressor pak controllers with version 5.XX software differ from earlier versions in that three sets of air dampers associated with each pak are now controlled by the pak electronics and not by a separate 'Staefa' controller.

This modification reduces the surplus heat generated by a pak when space heating is not required, and increases the surplus heat when space heating is required.

The modification includes changes to the condenser control algorithm as well as additional hardware and software for the damper control itself.

## 2 FUNCTIONAL DESCRIPTION

The heating and ventilation system integrates with paks as outlined in drawing SK337. The supply dampers and recirculation dampers are inversely coupled, ie when one is open, the other is closed.

The amount of heat supplied to heating and ventilation system is dependent on the air temperature and its volume. The amount of heat extracted from the gas in the condenser depends on the temperature difference between the condenser and the air passing through it.

For heating to be effective, the supply air temperature needs to be approximately 31 degrees C. To obtain optimum heating the condenser pressure is allowed to fluctuate within a wide band, maintaining the required air off temperature. When heating is not required the condenser pressure is held down for optimum refrigeration efficiency.

## 3 OPERATIONAL DESCRIPTION

### 3.1 MODE CONTROL

There are two modes of control, heating and refrigeration.

The mode selected depends on the outside air temperature and whether or not the main air handling unit fan is running.

The heating and ventilation control panel transmits a signal to the front end to indicate the fan status (Trend signal). The front end then sends this information to each pak in the system.

#### 3.1.1 Heating mode (see drawing SK338)

Heating mode is operational when either of the following conditions are true:

- (1) *Outside air temperature* is less than the *heating cut-in temperature* (F62) (ie zone 3).
- (2) *Outside air temperature* is greater than the *heating cut-in temperature* (F62) but less than the *heating cut-off temperature* (F61) (ie zone 2), and 'Trend' signal is present.

#### 3.1.2 Refrigeration mode (see drawing SK338)

Refrigeration mode is operational when either of the following conditions are true:

- (1) *Outside air temperature* is greater than *heating cut off temperature* (F61) (ie zone 1).
- (2) *Outside air temperature* is greater than the *heating cut-in temperature* (F62) but less than the *heating cut-off temperature* (F61) (ie zone 2), and 'Trend' signal is not present.

NOTE: NOT UNDER DOCUMENTATION CONTROL

## 3.2 CONDENSER CONTROL

The discharge pressure is controlled to a set-point and dead band as shown in drawing SK339.

Fan 1 is kept running unless all compressors are off AND the discharge pressure is very low. Other fans are switched on and off on a first on, first off basis.

### 3.2.1 Lowering discharge pressure

If the discharge pressure stays in the conditional lowering band for more than two minutes, or if it exceeds this band altogether, action is taken to reduce the pressure. The sequence is as follows: (assuming fan 1 only is on)

- (1) Open fresh air damper (see note 1).
- (2) Wait for this to have an effect (see note 2).
- (3) If pressure is too high, bring on another fan (note 3).
- (4) Wait for this to have an effect.
- (5) If pressure still too high, then bring on another fan.
- (6) Repeat (4) and (5) until all fans running.

#### Note 1

Fresh air dampers are opened and closed in steps. The number of steps between fully open and fully closed depends on the difference between the *outside air temperature* and the *condenser air on temperature*. Six temperature difference bands are recognised. The number of damper positions can be set by the hand held unit for four temperature difference bands.

#### Note 2

When a damper changes position, a timer is started. No further damper movement can occur until the timer has run out. If the damper is fully opened, the timer inhibits the switching on of the cooling fans. The initial and current values of the timer can be displayed on the hand held unit.

#### Note 3

When a fan is started or stopped a timer is activated. Fans cannot be started or stopped until this timer has run out. If the last fan (excluding fan 1) is stopped, this timer inhibits the damper closing operation. The initial and current values of the timer can be displayed on the hand held unit.

### 3.2.2 Raising discharge pressure

If the discharge pressure stays in the conditional raising band for more than two minutes, or if it gets below this band altogether, action is taken to raise the pressure. The sequence is as follows: (assuming more fans than fan 1 are running)

- (1) Switch off the longest running fan (excluding fan 1).
- (2) Wait for this to have an effect.
- (3) Repeat (1) and (2) until only fan 1 is running.
- (4) Wait for last fan switch off to have an effect.
- (5) If pressure is still too low, close fresh air dampers.

## 3.3 SUPPLY AIR TEMPERATURE (CONDENSER AIR-OFF) CONTROL

To raise condenser *air off temperature*, one of the following must occur:

- (1) Increase in condenser temperature.
- (2) Increase in Air on temperature (to condenser).
- (3) Reduction of air flow across the condenser.

NOTE: NOT UNDER DOCUMENTATION CONTROL

The fresh air dampers and cooling fans are used to control the condenser pressure. These are also used to control the air flow rate and air on temperature. To control the condenser air off temperature it is only necessary to modify the set-point used for condenser control.

The condenser control algorithm uses a set-point called the *current discharge pressure control set-point* (F29). This is variable between a lower limit (discharge pressure base set-point (F65)) and a higher limit (discharge pressure heating control maximum (F67)), both of which are programmable.

### 3.3.1 Variation of discharge pressure control set - point

This set-point can be switched between two values, one for use in refrigeration and the other for use in heating mode.

### 3.3.2 Refrigeration mode

When this mode is operational, the set-point is simply the *discharge pressure base set-point* (F65).

### 3.3.3 Heating mode

When this mode is operational, the set-point is a variable which the controller updates as follows:

The controller monitors the condenser *air off temperature* and compares this with the dead band. When the *air off temperature* goes outside the dead band the *pressure control set-point for heating* is incremented or decremented at a rate of 0.2 psi per minute.

It is this *pressure control set-point for heating* which is used for condenser control in heating mode. (As explained above the value is limited).

It is important to note that the value is being modified continuously regardless of the current operational mode. This means that while refrigeration mode is operative and the condenser pressure is being held down (and therefore the *air off temperature*), this value is likely to reach its maximum.

Therefore, when there is a mode change from refrigeration to heating the *current discharge pressure control set-point* will leap from its base limit to its maximum limit, giving the fastest possible response to a heating request.

## 3.4 **ADDITIONAL CONTROLS**

In conditions of extreme cold it may be necessary to take actions to control plant in a manner not already described.

### 3.4.1 Re-circulation dampers and supply dampers

As previously stated these two sets of dampers are inversely coupled and are now controlled by the pak electronics. Under normal conditions the re-circulation is fully closed the supply fully open, so that all available heat is given to the heating and ventilation system.

Any diversion of heat from the store circulation directly back into the plant room can only increase the tendency of the whole store to cycle down in temperature, as the amount of heat to be pumped by the refrigeration plant is reduced.

This reduces plant capacity, and hence reduces the heat generated. However, circumstances can arise where the diversion can be from 'dumping heat to atmosphere' to putting back into the plant room.

Re-circulation dampers are opened when the following conditions apply:

- (1) *Outside air temperature* is below the *heating cut-in temperature*, ie zone 3 heating mode is operative.
- (2) There is no BMS signal present, implying that the heat generated is being dumped to atmosphere.

NOTE: NOT UNDER DOCUMENTATION CONTROL

(3) The fresh air dampers are fully closed, ie the condenser is not being cooled. (Opening re-circulation would result in more cooling requirement).

In these circumstances the plant room can be used as heat store, and assist heating when the BMS signal returns.

#### 3.4.2 Gas dump valve and fan 1

It is possible that in conditions of extreme cold, the pak will over-condense and the discharge pressure will drop too low, even though only fan 1 is running and fresh air dampers are fully closed. In this condition two courses of action are available:

(1) Open the gas dump valve to increase the load, this brings on more refrigeration capacity thereby generating additional heat.

(2) Switch off fan 1 until the pressure rises again.

Both actions are available and will occur at pressures dependent upon parameters which can be preset as follows:

a) Gas dump valve is opened when the pressure falls to that set in (F75) and closed when pressure rises to (F75) plus 10 psi.

b) Fan 1 is switched off when pressure falls to that set in (F46) and the reaction timer is started. The fan is switched back on when the timer has run out and the pressure has risen above the *discharge pressure base set-point* (F65).

### 3.5 **HARDWARE MODIFICATIONS**

To accommodate damper control, hardware additions and modifications are required to supplied electronics, Main Systems supplied equipment and site wiring.

#### 3.5.1 Additional temperature probe (Outside air temp)

Drawing SK341 gives details for the probe connections to the pak mother-board for measurement of outside air temperature.

#### 3.5.2 Damper drive

An additional electronic circuit board fitted to the unused valve drive (VD) socket. Drawing SK342 gives details of the signal connections to the dampers from the pak mother-board. The latest issue DES-E-3016/4/E C.P drawing from Main Systems gives the power supply and wiring details.

#### 3.5.3 BMS signal

A pair of volt-free contacts in the heating and ventilation panel is connected in the front end.

### 3.6 **SYSTEM MODIFICATIONS**

#### 3.6.1 Status report

The new status report layout is shown in para 3.7.1

#### 3.6.2 Parameter reports

The new parameter report layouts are shown in para 3.7.2

#### 3.6.3 Novelties

NOTE: NOT UNDER DOCUMENTATION CONTROL

Some of the new parameters required by damper control are only available for operator modification via the hand held unit. These parameters are backed up in the front end in the normal way and their function numbers are 37, 46, 47 and 49.

<b>Compressor pak HHU functions (CP 5.XX)</b>				Defaults			
HHU	Description	Type	Limits/Units	2x3 LT	4x2 LT	2x3 IT	4x2 IT
00	Condenser air on temperature	D	deg C				
01	Condenser air off temperature	D	deg C				
02	Superheated suction temperature	D	deg C				
03	Superheated discharge temperature	D	deg C				
04	Heat reclaim water in temperature	D	deg C				
05	Heat reclaim water out temperature	D	deg C				
06	Rate of change of suction pressure	D	psi/min				
07	-						
08	Suction pressure	D	psi				
09	Discharge pressure	D	psi				
10	Max number of stages comp 1	S	0 to 3	3	2	3	2
11	Total running time comp 1	D	hours/10				
12	Number of stages on line comp 1	D					
13	-						
14	Fault status comp 1	A	0= OK, 1=alarm				
15	Time before starting comp 1	D	0 to 7 minutes				
16	-						
17	-						
18	-						
19	-						
20	Max number of stages comp 2	S	0 to 3	3	2	3	2
21	Total running time comp 2	D	hours/10				
22	Number of stages on line comp 2	D					
23	-						
24	Fault status comp 2	A	0= OK, 1=alarm				
25	Time before starting comp 2	D	0 to 7 minutes				
26	-						
27	-						
28	Current discharge pressure control setpoint	D	psi				
29	Heat flag from front end (1=Heat)	D					
30	Max number of stages comp 3	S	0 to 3	3	2	3	2
31	Total running time comp 3	D	hours/10				
32	Number of stages on line comp 3	D					
33	-						
34	Fault status comp 3	A	0= OK, 1=alarm				
35	Time before starting comp 3	D	0 to 7 minutes				
36	-						
37	Number of damper positions for (air on - outside air) temp difference *	S	2222 to 6666				
38	-						
39	-						
40	Max number of stages comp 4	S	0 to 3	3	2	3	2

NOTE: NOT UNDER DOCUMENTATION CONTROL

41	Total running time comp 4	D	hours/10				
42	Number of stages on line comp 4	D					
43	-						
44	Fault status comp 4	A	0= OK, 1=alarm				
45	Time before starting comp 4	D	0 to 7 minutes				
46	Discharge pressure to tun fan 1 off	S	110 to 150 psi	130	130	130	130
D = DISPLAY S = SETTABLE A = ALARM							
<b>Compressor pak HHU functions (CP 5.XX)</b>				Defaults			
HHU	Description	Type	Limits/Units	2x3 LT	4x2 LT	2x3 IT	4x2 IT
46	Discharge pressure to tun fan 1 off	S	110 to 150 psi	130	130	130	130
47	Programmable initial value for damper reaction timer	S	30 to 180 secs	60	60	60	60
48	Reaction timer	D	secs				
49	Programmable initial value for fan reaction timer	S	60 to 240 secs	180	180	180	180
50	Dead band upper limit	S	5 to 45 psi	8	8	40	40
51	Dead band	S	1 to 10 psi	2	2	10	10
52	Conditional increase differential	S	0 to 10 psi	3	3	5	5
53	Conditional decrease differential	S	0 to 10 psi	3	3	10	10
54	Change of pressure to inhibit decrease	S	0 to 5 psi	3	3	3	3
55	Change of pressure to inhibit increase	S	0 to -5 psi	-3	-3	-3	-3
56	Desired capacity stages (100 = auto)	S	0 to 100	100	100	100	100
57	Capacity increase counter	D					
58	Capacity decrease counter	D					
59	Load share timer	D					
60	Outside air temperature	D	deg C				
61	Heating control cut off temperature	S	10 to 35 deg C	18	18	18	18
62	Heating control cut in temperature	S	-5 to 5 deg C	2	2	2	2
63	Condenser air off heating setpoint	S	25 to 35 deg C	31	31	31	31
64	Condenser air off heating dead band	S	2 to 4 deg C	2	2	2	2
65	Discharge pressure base setpoint	S	140 to 250 psi	140	140	140	140
66	Discharge pressure dead band width	S	1 to 20 psi	20	20	20	20
67	Discharge pressure heating control maximum	S	150 to 290 psi	210	210	210	210
68	Number of fans available	S	2 to 4	2	3	2	2
69	Number of fans running	D	2 to 4				
70	Low suction pressure alarm limit	S	0 to 30 psi	1	1	25	25
71	High suction pressure alarm limit	S	10 to 79 psi	25	25	55	55
72	High discharge pressure alarm limit	S	250 to 300 psi	280	280	280	280
73	Discharge temperature to open liquid injection valve	S	100to 120deg C	105	105	105	105
74	Discharge temperature differential to close liquid injection valve	S	1 to 10 deg C	2	2	2	2
75	Discharge pressure to open dump valve	S	100 to 190 psi	155	155	155	155
76	Set discharge pressure to force capacity decrease	S	250 to 300 psi	275	275	275	275
77	Suction pressure to inhibit stage 3	S	0 to 100 psi	80	80	80	80

NOTE: NOT UNDER DOCUMENTATION CONTROL

78	Suction pressure to inhibit stage 2	S	0 to 100 psi	90	90	90	90
79	Sequential start timer	D	seconds				
80	Low air flow alarm	A	0=OK, 1=alarm				
81	Fan fault	A	0=OK, 1=alarm				
82	Low refrigerant alarm	A	0=OK, 1=alarm				
83	More data needed	A	0=OK, 1=alarm				
84	Temperature sensor failure	A	0=OK, 1=alarm				
85	Backed up data corrupted	A	0=OK, 1=alarm				
86	Pressure sensor failure	A	0=OK, 1=alarm				
87	Low suction pressure alarm	A	0=OK, 1=alarm				
D = DISPLAY S = SETTABLE A = ALARM							
<b>Compressor pak HHU functions (CP 5.XX)</b>				Defaults			
HHU	Description	Type	Limits/Units	2x3 LT	4x2 LT	2x3 IT	4x2 IT
88	High suction pressure alarm	A	0=OK, 1=alarm				
89	High discharge pressure alarm	A	0=OK, 1=alarm				
90	RAM fail alarm	A	0=OK, 1=alarm				
91	PROM checksum fail	A	0=OK, 1=alarm				
92	PC out of range	A	0=OK, 1=alarm				
93	SP out of range	A	0=OK, 1=alarm				
94	Background execution fault	A	0=OK, 1=alarm				
95	WPRAM fail	A	0=OK, 1=alarm				
96	NOVRAM fail	A	0=OK, 1=alarm				
97	Software version number	D					
98	Force data set up from bit switches	D		301	305	302	306
99	Set device number	S	300.0 to 319.9	300	300	300	300
D = DISPLAY S = SETTABLE A = ALARM							

\* Note:

FUNCTION (F37):

Changes to these values only take effect when the dampers are fully closed.

Digit indications (left to right) are as follows:

- (1) Digit 1: Number of damper positions if <air on-outside air> is between 20 and 25 deg C.
- (2) Digit 2: Number of damper positions if <air on-outside air> is between 15 and 20 deg C.
- (3) Digit 3: Number of damper positions if <air on-outside air> is between 10 and 15 deg C.
- (4) Digit 4: Number of damper positions if <air on-outside air> is between 5 and 10 deg C.

DEFAULTS

Default to 2 damper positions if <air on-outside air> is less than 5 deg C.

Default to 6 damper positions if <air on-outside air> is greater than 25 deg C

NOTE: NOT UNDER DOCUMENTATION CONTROL