HFG

HAGENUK FAIVELEY GmbH

EMU Class72 (NSB)

Functional Description
(Software specification)

driver´s cabine

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1 Regulation and control

To control the HVAC system there are three modes implemented in the software:

testmode
failure mode
normal mode

1.1 Test modes

This mode is availible with all HFG service programs („SPP“ or „ISP“). Further a PC and a serial link between PC and controller FPC4R is necessary.
The test modes can be started
1) directly on the FPC4R or
2) from the FPC20/2 controller via CAN-bus or
3) with a bus signal from the RS485 interface.
Only one source can start the testmodes. Signals from another source at the same time will be ignored.
After a testmode from the FPC4 the FPC4 must be resetted to go back to the normal regulation.
After a testmode from the FPC20/2 the FPC20/2 controller must be resetted to go back to the normal mode.
After a testmode from the RS485 the driver´s cab will be go back to the normal regulation if the bus signal „testmode“ BC560) will go OFF.

It is possible to test single functions of the unit including all safety conditions:

	Testmode	**Outputs to be set on**	**Input conditions**
1.	[ ] prepare_mode	- prepare (BY001)	- 400V OK (BA004=1L)
2.	[ ] convection_heater	- convection heater (BY002/TY002)	---
3.	[ ] cooling	- compressor (BY003)	- 400V OK (BA004=1L) - ventilation on (BA003=1L) - low pressure OK (BA002=1L) - not „compressor OFF“ signal (BA001=0L)
4.	[ ] airheater	- airheater (BY004/TY004)	- 400V OK (BA004=1L) - ventilation on (BA003=1L) - duct temperature<70°C

1.2 Failure mode

1.2.1 Sensor error

In case of defect analog sensors (short circuit or open loop) the units will be work in reduced function:

Sensor error	Effect
outside air sensor defect (AA001)	switch to fixed value (21°C), no UIC correcture for the setpoint possible
duct temp. sensor defect (AA002)	no duct regulation possible, airheater will be controlled by the room temperature
room temp. sensor defect (AA003)	heating and cooling will be controlled by the duct and outside temperature
room **and** duct temp. sensor defect (AA003 + AA002)	no heating and cooling possible, only ventilation active (hardware)
set point switch defect (AA004)	switch to fixed value (21°C)

1.3 CAN-bus information

By the RS458 interface and with the HFG - CAN-bus the FPC4R controller gets additional information

- about the power supply (400V ok, 1000V ok)
- about the test modes (choosed from the FPC20/2 controller or from the car bus)
- about the mode „local automatic“ (choosed from the FPC20/, input BA020)

The FPC4R controller will give status and service informations (errors) to the CAN-bus.

1.4 Normal mode

The regulation of HVAC system is controlled by a microcontroller FPC4R.
If the controller is running (supply voltage on) the regulation will start working in normal mode.

The mode „prepare“ is choosed, if the signal „prepare drivers cab“ from the RS485 (via CAN-bus) is present.

The supply fan is switched in maximum speed (hardware, relais K04 with output BY001). The room temperature should be minimum 20°C and maximum 24°C.

1.5 Regulation

The controller supplies in cooling mode (TR> setpoint) a room temperature according the UIC553 norm. The setpoint can be choosed by a switch with three positions (MIN = setpoint - 2°C , MED = UIC553 setpoint , MAX = setpoint + 2°C). If the outside temperature is higher than 19°C the room temperature setpoint will be

$TR_w = 22°C + 0.25(TO-19K)$

The room temperature will be controlled by the convection heater and the compressor. In heating mode ($TR<TR_w$) the supplied air (duct temperature) will be regulated to a value of TR_w+2K .

1.6 Supply fan

The supply fan can be work in three ventilation steps (Auto1, Auto2 and Auto3) choosed manuel by the „mode selection switch“ (hardware).

The reply about a switched fan (contactors from all fan relais) and a present airflow is available on the digital input BA003. If signal BA003=1L it is allowed to switch on the airheater or the compressor.

1.7 Air heating command

The airheater is controlled by a regulation circuit to regulate the duct temperature. The nominal duct temperature is a function of the set point switch and the outside temperature.

The duct regulation is realised by a pulsing heating output. The time shedule for the heating regulation will be 1 minute (max. 60 switches per hour, every minute a new decision how long the heating time will be).

If heating command is less than 5 seconds the controller do not swich on the heater.
If heating command is more than 55 seconds the controller do not swich off the heater.

The airheater will be switch off if

- duct temperature is too high (more than TR_w+10K, AA002) (switch off for minimum 30 sec.)

- no fan step is active or no airflow is detected (BA003=0L)
- the room sensors and the supply air sensor are defect
- the power supply is not available (no 400V, BA004=0L)
- the high voltage is off (bus information „1000V ok“) and no „local auto“ is selected by the FPC20/2 (bus information)
- the compressor is not active (and 5 minutes after)

1.8 Convection heater

The convection heaters in the drivers cab will be controlled by the room temperature sensors.

The regulation is realised by a pulsing output. The time shedule for the heating regulation will be 1 minute (max. 60 switches per hour, every minute a new decision how long the heating time will be).

If heating command is less than 5 seconds the controller do not swich on the heater.
If heating command is more than 55 seconds the controller do not swich off the heater.

The convection heater will be switch off if
- the room sensors and the supply air sensor are defect
- the high voltage is off (bus information „1000V ok“) and no „local auto“ is selected by the FPC20/2
- the compressor is not active (and 5 minutes after)

1.9 Cooling unit

The cooling unit will be controlled by the room temperature.

After switch on the compressor the high pressure will be controlled by the safety chain (hardware).

120 seconds after switch on the compressor the low pressure switch will be controlled. If a low pressure situation is detected (BA002=0L) the software will switch off the cooling outputs for the minimum waiting time. The compressor is able to start if the low pressure is switched to OK (BA002=1L).
If a low pressure will be detected three times in 30 minutes an error signal will be generated and the compressor is blocked permanently.

The time between two compressor starts is fixed to maximum 10 starts per hour.
The minimum waiting time between compressor stop and start is fixed to one minute.

The cooling unit will be switched off, if
- the control signal „compressor OFF“ is active (BA001)

- the duct temperature is too cold (less than 5°C, AA002)
- the outside air is too cold (less than 10°C, AA001)
- no fan step is active or no airflow is detected (BA003=0L)
- the room sensor and the supply air sensor are defect
- the power supply is not available (no 400V, BA004=0L, fast switch off also for short line breaks >50ms)
- a low pressure situation is present (BA002=0L)
- a heater is active (convection heater or airheater) and 5 minutes after

1.10 Error messages

If a failure occurs during the normal conditions (valid mode selected) or during the test modes the failure will be switch off parts of the HVAC system. The failure situation will also be sended via CAN-bus to the car bus (bit coding).

All faults will be stored in the error memory of the controller.

1.11 Error memory

The error memory of the microcontroller FPC4R is able to store some faults of the units. The memory can be read or erase with a HFG service program or a standard terminal program.

Following are listed all error numbers:

error number	defect
101	sensor outside temp. defect (AA001)
102	sensor duct temp. defect (AA002)
103	sensor room temp. defect (AA003)
104	setpoint switch defect (AA004)
105	c0 failure (internal hardware error AIC, analog input control)
106	c1 failure (internal hardware error AIC, analog input control)
107	low pressure failure (3 times in 30 minutes)

2 Interface to system software FPC4R

2.1 Supply voltage

SW adress	connector X..	meaning
	X1:1	N24V DC
	X1:2	P24V DC

2.2 Analog inputs (NTC sensor)

SW adress	connector X..	meaning
AA001	X6:1	AGD (analog ground)
	X6:2	outside temperature (TO)
AA002	X6:3	AGD
	X6:4	duct temperature (TD)
AA003	X6:5	AGD
	X6:6	room temperature (TR)
AA004	X6:7	AGD
	X6:8	setpoint switch (TR_w)

2.3 Digital inputs

SW Adress	connector X..	meaning
BA001	X2:7	compressor OFF
	X2:6	N24V DC
BA002	X2:5	low pressure OK
	X2:4	N24V DC
BA003	X2:3	ventilation on + airflow ok
	X2:2	N24V DC
BA004	X2:1	400V OK

2.4 Relais outputs

SW Adress	connector X..	meaning
BY001	X3:6	prepare mode
	X3:5	P24V DC
BY002	X3:4	convection heater
BY003	X3:3	compressor
	X3:2	P24V DC
BY004	X3:1	airheater

2.5 Interface CAN-BUS

SW Adress	connector X..	meaning
	X4:1	CAN high
	X4:2	CAN low
	X4:3	
	X4:4	

2.6 Serial interface RS232C

SW Adress	connector X..	meaning
	X5:1	TX
	X5:2	GND
	X5:3	RX

2.7 DIP-switches (on board)

SW Adress	switch	meaning
BA010	S1	DIP 1.1 (application software „on“))
BA011	S1	DIP 1.2
BA012	S1	DIP 1.3
BA013	S1	DIP 1.4
BA014	S2	DIP 2.1 (CAN)
BA015	S2	DIP 2.2 (CAN)
BA016	S2	DIP 2.3 (CAN)
BA017	S2	DIP 2.4 (CAN)