

**SHANGHAI FAIVELEY RAILWAY TECHNOLOGY CO.**

**AMSTERDAM (Alstom)**

**3 OPERATING INSTRUCTIONS**

# SHANGHAI FAIVELEY RAILWAY TECHNOLOGY CO.

## Release History

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Released by	Olaf.Giel	EH	15.10.2010	

## Revision Table

Revision	Date	Revised Sections, Description, Reason for changes
01	15.10.2010	First issue

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## **3 OPERATING INSTRUCTIONS**

### **3.1 GENERAL FUNCTIONS**

Main function of the control system is ensuring adequate comfort regarding room temperature, supply air temperature and air volumes in accordance with the requirements. Changing conditions such as different outside temperature, solar radiation, humidity, and changes of supply voltage are to be compensated.

Furthermore the control system has to monitor the proper function of all components and has to transfer detailed diagnosis information to the central diagnosis system in cases of faults. Dangerous conditions are to be prevented.

HVAC controller FPC and TCMS will communicate via CAN network. FPC shall send the status of the HVAC unit as well as the outside temperature and the interior temperature to TCMS.

Service functions such as software-download, the start of test-modes or signal recording are to be feasible via the USB interface. For maintenance purpose FAIVELEY offers the special developed Maintenance software Mona.

### **3.2 HVAC START UP SELF-TEST MODE**

A self-test is performed when the controller is powered on for the first time and test mode is not activated by MONA. Self test sequence will be activated once each time after the controller is powered ON for the 1<sup>st</sup> time.

In this process, the controller tests all temperature sensors, tests the train bus system initialization and etc. Then the controller records the result of self-test. After self test process, the controller switches to the mode selected by the mode switch.

### **3.3 TEST MODE REALIZED BY MONA**

Each component can be tested with FAIVELEY maintenance software called MONA. The detail method of test mode realized by MONA is described in the control function description of each component in the next chapters such as supply fan, condenser fan, compressor, and so on.

During test mode, the system fault information light shall flash ON.

### **3.4 OPERATION MODES**

This section gives an overview of how to define operation mode and status signal, and also internal status. Three kinds of signals can affect the operation mode of HVAC unit. They are:

- Signals from TCMS via CAN
- Signals from hardwired inputs
- Signals from maintenance software MONA

Although the signals from TCMS can affect the operation mode more frequently, the signals from maintenance software and from hardwired inputs have higher priority. See below:

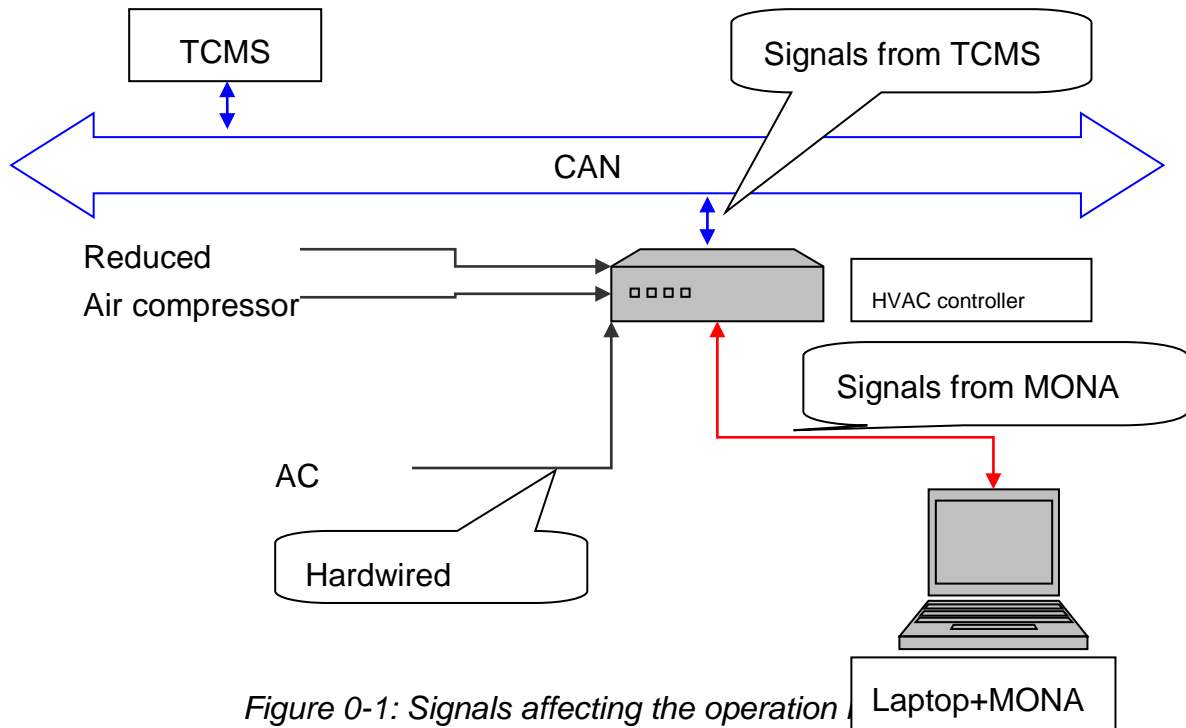


Figure 0-1: Signals affecting the operation

**The control of the HVAC unit is separated into following modes:**

- Self test procedures during startup
- Test mode via Mona
- OFF mode (Hardwired AC power OK signal or signal from TCMS)
- Emergency mode (Signal from TCMS)
- Only ventilation mode
- Slumber mode
- Station mode (Signal from TCMS)
- Automatic mode (Signal from TCMS)

In “Automatic mode”, control of ventilation or cooling or heating is dependent on the temperature set point and temperatures of return air, supply air and fresh air.

Starting sequence of HVAC module is:

- Supply air fans
- Condenser fans
- Compressors

The controller starts relevant modes depending on train bus information, temperature (inside and outside), Furthermore the controller receives feedback from the components and derives the current operation condition. The controller classifies failures and errors are stored in event memory. Operating conditions and error messages will be sent from the digital controller to the train system via train bus.

#### **OFF mode**

If the AC power supply for unit is not OK or the TCMS send the “OFF” signal to the HVAC controller, the HVAC will run in Off mode. Only the controller is powered. Ventilation and air conditioning are forbidden. If the OFF mode is active, the TCMS system receives all available signals, such as temperatures.

#### **Automatic mode**

In automatic mode, the HVAC unit will be completely controlled by the controller. Cooling, heating and ventilation are allowed. HVAC unit performs according to the defined temperature regulation. The set point of the passenger compartment temperature can be adjusted to the value within  $\pm 2K$  related to the defined temperature regulation via train bus.

According to the calculation of cooling, heating or ventilation requirement, the HVAC controller set the unit in proper sub modes:

- Ventilation
- Half cooling
- Full cooling
- Heating
- Pre-cooling and Pre-heating

According to the calculation of return air and fresh air, there are two cooling modes can be set by controller.

- Half cooling mode: when the calculated value is from 5%...50% of cooling needing, the HVAC unit will run with one compressor;
- Full cooling mode: when the calculated value is over 50% for cool needing, the HVAC unit will run with two compressors;
- During pre-cooling and Pre-heating the fresh air dampers are closed and the units are running with 100% return air until the set point is reached (may limited by a time frame);
- When there is heating needing, the HVAC will turn to “Heating” mode, the compressor will be stopped and heater be started;
- When there isn't cooling and heating needing, the HVAC will turn to “Ventilation” mode, the HVAC system will stop the compressor, heater, condenser fan, only the supply air fan is running which used to provide fresh air.

The refrigerant circuit is equipped with a hot gas bypass regulator. When the cooling demand is under a level causing the evaporation pressure and temperature to be under a certain unwanted value, the bypass regulator opens allowing hot gas to flow directly into the evaporator and raises evaporation pressure to an acceptable level. The suction (evaporation) pressure is the control-parameter for the bypass regulator.

#### **Station mode**

In order to reduce noise, when the train is at station (the train speed is lower than 5km/h), the unit will operate in low ventilation mode for a maximum time of 1 minute. The time limitation may be modified by TCMS software. In this mode the cooling capacity will be reduced.

In this mode, the HVAC is running at the compound mode of “Station” and “Automatic”, except that the supply air fans run at low ventilation, other components would act as same as in “Automatic” mode.

#### **Emergency mode**

The emergency mode will be activated via train bus in case of missing 400V auxiliary power or when the controller finds that the train bus fails the unit will realize emergency ventilation automatically. The fresh air dampers are open and return air dampers are closed. All auxiliary heaters are switched off. Supply air fans are in operation and they will be powered from train. The voltage and frequency of power supply from train is 250Vac 35Hz.

#### **Slumber mode**

The objective of this Slumber mode is to maintain a predefined temperature inside the vehicle.

The temperature set point in this mode is 5°C. This value is a parameter and can be adjusted per the maintenance software. This value must be kept when the maintenance computer is disconnected.

When Slumber mode is selected and send to the HVAC system through the TCMS, all HVAC of the train are stopped.

When each HVAC need to start the heater in order to respect the temperature set point, HVAC system put the information “Heating need” from 0 to 1.

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The train sends through the input hardware “authorization ventilation” (from 0 to 1) to all HVAC.

The HVAC system can start the fan and the heater.

When HVAC doesn't need to heat the information “Heating need” go from 1 to 0.

The train removes the input hardware “authorization ventilation” (from 1 to 0) to all HVAC.

### 3.5 SUMMARY COMPONENTS' ACTIONS IN RELATED MODES

Mode components	OFF mode	Emergency mode	Station mode	Automatic mode		
				Ventilation	Cooling	Heating
Supply air fan	OFF	ON	Low speed	ON	ON	ON
Condenser fan	OFF	OFF		OFF	ON	OFF
Compressor	OFF	OFF		OFF	ON	OFF
Heater	OFF	OFF		OFF	OFF	ON
Return air damper		Closed				

Note:

- There are two sub modes in the automatic cooling mode: Half cooling mode, Full cooling mode. In former one, there is only one compressor running, in the latter one, there are two compressors running.

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- Pre-heating mode and pre-cooling mode is almost the same as heating and cooling mode, the only difference is that in former mode, the fresh air damper should be closed.
- In station mode, the HVAC runs almost the same as automatic mode, only difference is that the supply air fan runs at low speed in former mode.