



FAN COIL CONTROLLER USER MANUAL

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1 Scope

This document describes the features, specifications and general operation of the DJ1011-1 Fan Coil Controller (FCC). Setting up the unit with the mlm Tool application software is also described.

2 Fan Coil Controller Overview

The FCC manages the operation of two-pipe and four-pipe Fan Coil Units (FCUs). Electric heating control is also supplied. The FCC interfaces to EC fans, 3-speed fans, analogue valves, 220VAC valves and electric heating elements in various configurations. The FCC contains an integrated AC/DC power convertor and is powered directly from 220VAC mains.

Two dry contact inputs are provided allowing a PIR motion sensor and/or door or window switch to override the operation of the FCC. A regulated 12V output is available to power devices such as PIRs directly from the controller.

The FCC features water supply change-over temperature sensing, both hot-to-cold and cold-to-hot. It therefore allows two-pipe FCUs to be operated without the need for electric heating.

The FCC operating parameters and functions are configured by the mlm Tool application software, revision 8.17 u8 or later. In addition to the mlm Tool, the FCC operating modes and setpoint can also be adjusted externally by a Fan Coil wallstat,.

3 Features

3.1 Operational

- Three basic modes of operation are provided: Fan-only, automatic-fan/automatic-temperature (Full Auto) and manual-fan/automatic-temperature (Auto) control.
- PI temperature and fan speed control with adjustable gain and reset rates.
- Fan type selection 3-speed or EC.
- Max fan speed selection for heating and cooling modes.
- Five valve control modes to choose from, including 6-way valve and change-over sensing for single valve (2-pipe) control.
- Adjustable electric heater rundown timer.
- Powerup mode can be pre-selected.
- Occupancy and door switch functions configurable for input type, action delays and operating modes.
- Multi-zone operation where inputs from a mlm diffuser network is used to calculate heating, cooling and fan speed demand.¹

¹ See doc DM0073-0016 (Multi-zone diffuser setup).

3.2 Hardware features

- Single 220VAC ($\pm 10\%$) power supply input
- Cold and hot water on/off 220VAC triac valve control
- Modulated hot/cold valve (0-10V) control
- Electric heater on/off relay control
- 3-speed relay or EC (0-10V) fan speed control
- Three temperature sensor inputs – Room, Change Over and Auxiliary sensing provided
- Interface to mlm network for expansion to multiple controllers and diffusers
- Interface to Fan Coil wallstat.
- Interconnect to MCU gateway for expansion to BACnet BMS network
- Dry contact inputs for detecting Occupancy and Door switch activity

3.3 User Interface

- Fan Coil Wallstat (wallstat) –serves as a user interface to the FCC. It contains a LCD screen and push button inputs for the user to set-up the mode of operation, monitor control status and display diagnostic information.
- Mlm Tool –application software which communicates to a FCC and diffuser network via a USB or Ethernet port. The mlm Tool is used to configure and set-up a diffuser and Fan Coil network of controllers. It can log trend information and is also used for debugging and fault tracing.

4 Product Specifications

4.1 Power Supply

- 220V~ $\pm 10\%$, 50Hz $\pm 10\%$
- Power Consumption: 3.3W absolute max (excluding heater, fan and valves)

4.2 Environmental

- Operating Temperature Range: 0 to +50°C
- Storage Temperature Range: 0 to +70°C
- Safety Rating: SANS / IEC 60950-1

4.3 Maximum Electrical ratings⁽²⁾

- Heater Element: 220V~, 2kW max
- 3-Speed Fan: 220V~, 1kW/contact
- AC Valves: 220V~, 100mA
- Aux 12V supply: 13V \pm 1V, 100mA
- Analogue Controlled EC Fan: 0-10V, 10mA max (1k input impedance)
- Analogue Controlled Valves: 0-10V, 10mA max (1k input impedance)

4.4 Available Variants

The Fan Coil Controller is available in two variants with the following electrical features:

Table 1: FCC variants

Variant	A	B
Electric Heater	YES	NO
3 Speed Fan	YES	YES
220V Valves	YES	YES
Dry Contact Inputs	YES	YES
EC FAN	YES	YES
Analogue Valves	YES	YES
Temperature Sense	YES	YES
MLM Interface	YES	YES
12V aux supply	YES	YES

5 Control Scheme

5.1 PI control loop

A single Proportional-Integral (PI) algorithm calculates the control output on a continuous basis. All the control elements (heater, valves and fan) of the FCC operate off this output. The analogue outputs of the FCC are directly linked to this output, whereas discrete outputs such as the 3-speed fan, AC valves and electric heater operate at pre-set switching levels based on the control output. Table 2 indicates the switching points of the discrete control elements.

Inputs to the algorithm are the Room and Changeover temperature measurements as well as the Setpoint value. The output is supplied to the control elements, i.e. valves, heater and fan, to control the room temperature to setpoint. The Heating, Cooling and Idle states of operation are also a function of the PI controller.

The gain and reset rate of the PI loop can be adjusted to optimise the temperature response.

Table 2: Discrete Control Levels

Control Element	3 Speed Fan	220V Valves	Electric Heater
Control Method	PI Controlled	PI Controlled	Proportional
	Off = 0%	On and off limits configured via SDO[79]	On > 0.5°C below setpoint Off ≤ 0.2°C below setpoint
	Low > 0%		If Heating valve selected the PI control output must reach 100% before the Electric Heater is enabled.
	Medium > 33% on ≤ 33% off		
	High > 66% on ≤ 66% off		

5.2 Heating & Cooling valves

Analogue input or 220VAC on/off type valves are supported. The FCC analogue outputs will follow the PI controller output for 0 to -100% in the cooling and 0 to +100% in the heating states of operation.

The AC valves can be set to switch on and off at specific control (demand) values, with the default set at 50% on and 10% off – SDO(79) command. This will hold true for both Heating and Cooling cycles. Note the 'on' % value must be greater than the 'off' value.

5.3 Electric heater

If the heating valve is selected, the electric heater has an ancillary function. Once the PI reaches maximum demand (100%) in heating state, the electric heater is enabled. Once the temperature delta then exceeds 0.5°C below setpoint the heater will switch on. When the temperature delta closes to below 0.2°C the heater will switch off.

If the heating valve is not selected and the heater is the primary heating device, the heater will simply switch on when the temperature exceeds 0.5°C below setpoint and will switch off again at 0.2°C below setpoint.

During electric heating the fan will always be on. A run down timer with an adjustable duration will delay the fan off when the electrical heater is turned off.

5.4 Fan control

The user has the option to select EC (analogue output) or 3-speed fan control. The fan speed output will follow the PI controller output between the minimum and maximum heating and cooling limits as selected with the setup wizard. Note a fan speed selection of off (3-speed) or 0% (EC) will prevent the FCC from entering either the heating or cooling modes of operation.

Table 3: Relationship between PI control, EC Fan and 3-Speed Fan outputs

PI control output	EC Fan output	3-Speed Fan
0%	0V	Off
1% - 33%	0.1 – 3.3V	Slow
34% - 66%	3.4 – 6.6V	Medium
67% - 100%	6.7 – 10V	High

5.5 Operation modes and Control State

The FCC can be selected for the following modes of operation:

- Off
- Fan only
- Full auto (auto fan/auto temperature)
- Auto (auto temperature/manual fan)

The FCC can be selected to operate in one of these modes by:

- Wallstat on/off button
- Wallstat Operating Mode set menu
- Mlm Tool command – Process/Operating mode on FCC node editor, only if a wallstat not connected.
- Mlm Tool command – Process/Operating mode in wallstat node editor
- BMS command – see Doc DM0073-0021 (BMS BACnet interface to FCC).

The FCC can be in one of the following control states:

- Off
- Idle
- Fan Only
- Cooling
- Heating
- Override

6 Installation and Commissioning

The Fan Coil Controller can be connected to a standard mlm24 installation and interfaces with the MLM Tool V8.17 u4 and higher for commissioning and diagnostics.

6.1 Hardware installation

The Fan Coil Controller manages the operation of either two-pipe or four-pipe Fan Coil Units. Electric heating is optional. The Fan Coil Controller incorporates a 220VAC to 12VDC SMPS removing the need for a separate power supply or transformer.

Two dry contact inputs are supplied allowing a PIR and/or door or window reed switch to override the operation of the Fan Coil Controller. In addition, a regulated 12V supply is available allowing devices such as PIRs to be directly powered from the Fan Coil Controller. The wiring diagram for the Fan Coil Controller is shown in Figure 1.

6.2 FCC wiring connections

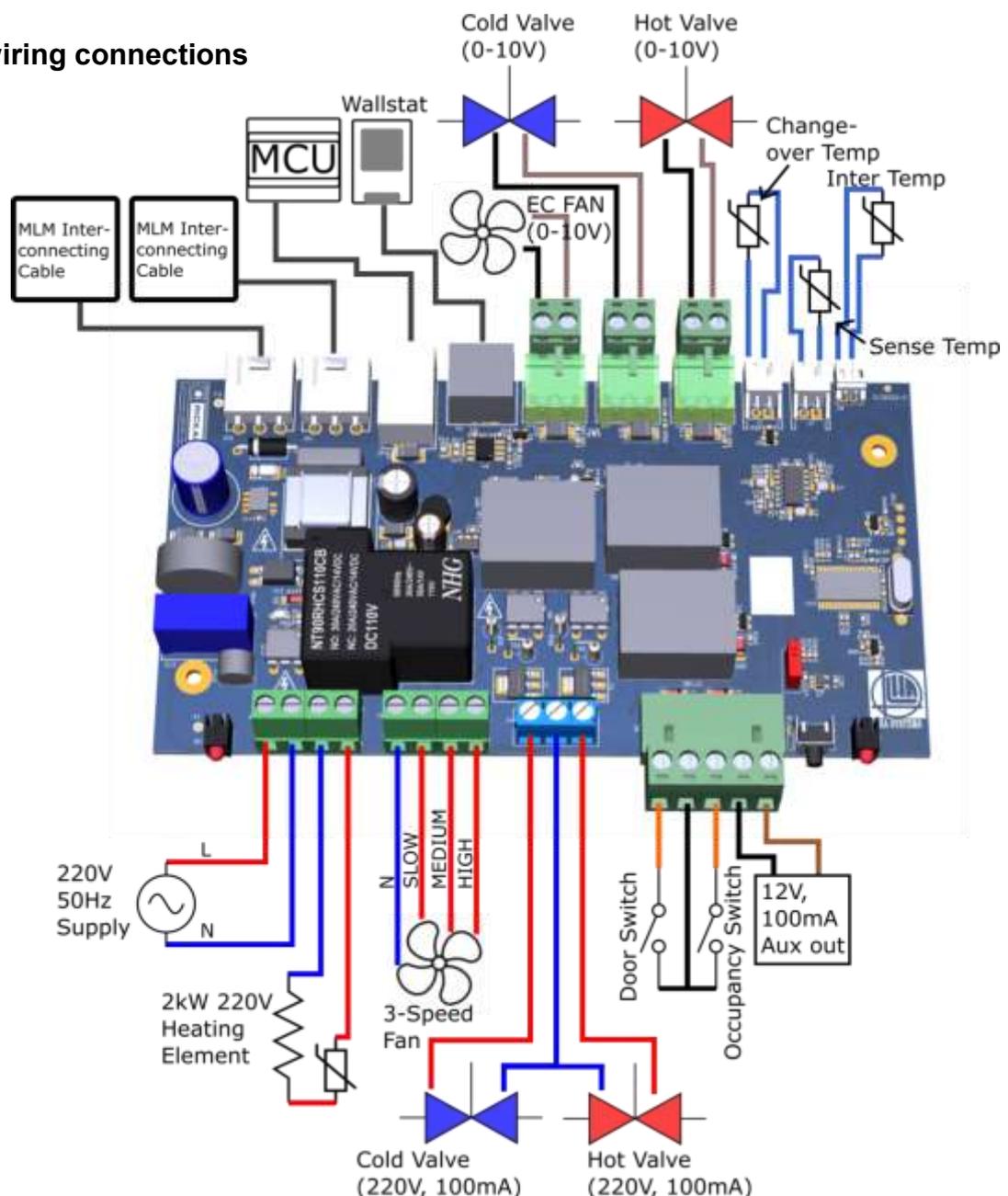


Figure 1: Fan Coil Wiring Diagram

6.3 Hardware configuration

Once the wiring is completed, the controller requires the hardware to be set up to match the FCC I/O to the connected hardware. The mlm Tool application is required to do this. For the mlm Tool operations description consult doc DM0070 issue 4.

Ensure the FCC is powered and operating, with the mlm Tool connected as shown in Figure 2. At this stage the units are not set up and still on zone 0. If a wallstat is connected to the controller, verify the wallstat connectivity by expanding the icon as shown in Figure 3.

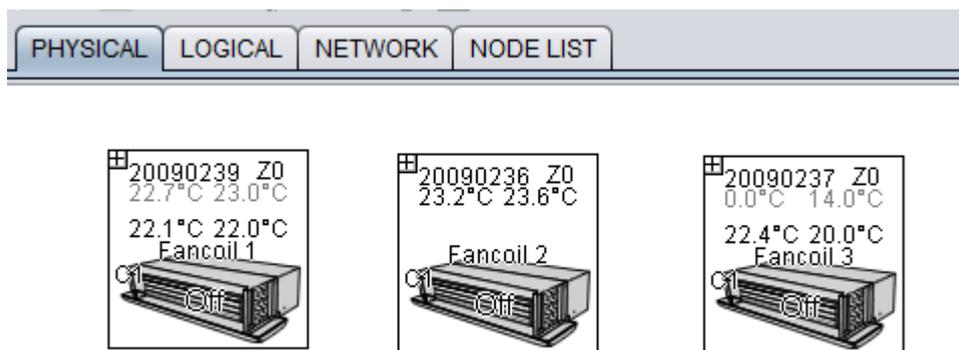


Figure 2: FCCs visible in mlm Tool Physical screen

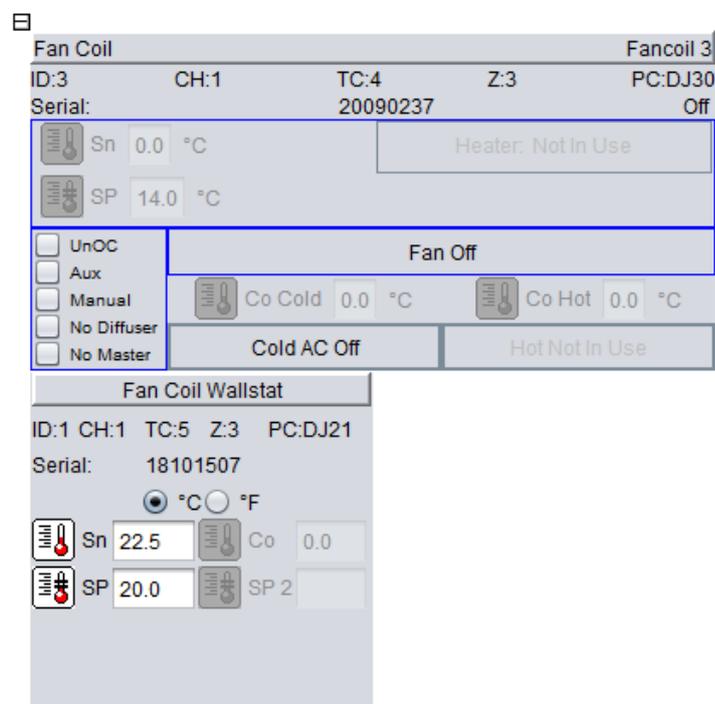


Figure 3: FCC with wallstat expanded icon

In the Edit menu the FCCs can now be zoned sequentially and the changes saved. This 'save on exit' function saves the project setup. If the section is now disconnected and connected again, the project will display this last saved status. Should wallstats be in use, only one wallstat can be connected per zone.



Figure 4: Save zoned FCCs

6.4 Configure the FCC(s) with the Setup Wizard

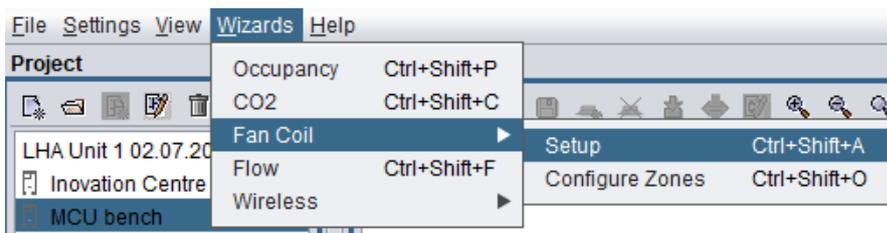


Figure 5: Select Wizards/Fan Coil/Setup

The first page of the wizard is intended for multi-zone operation. This process is described in detail in document DM0073-0016 (Multi-zone diffuser setup). For our purpose we will move on to the next page.

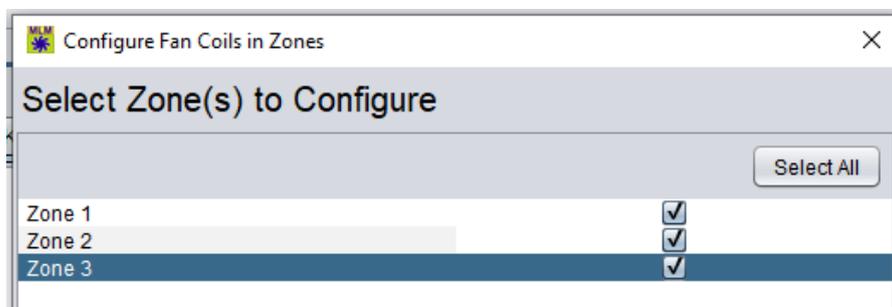
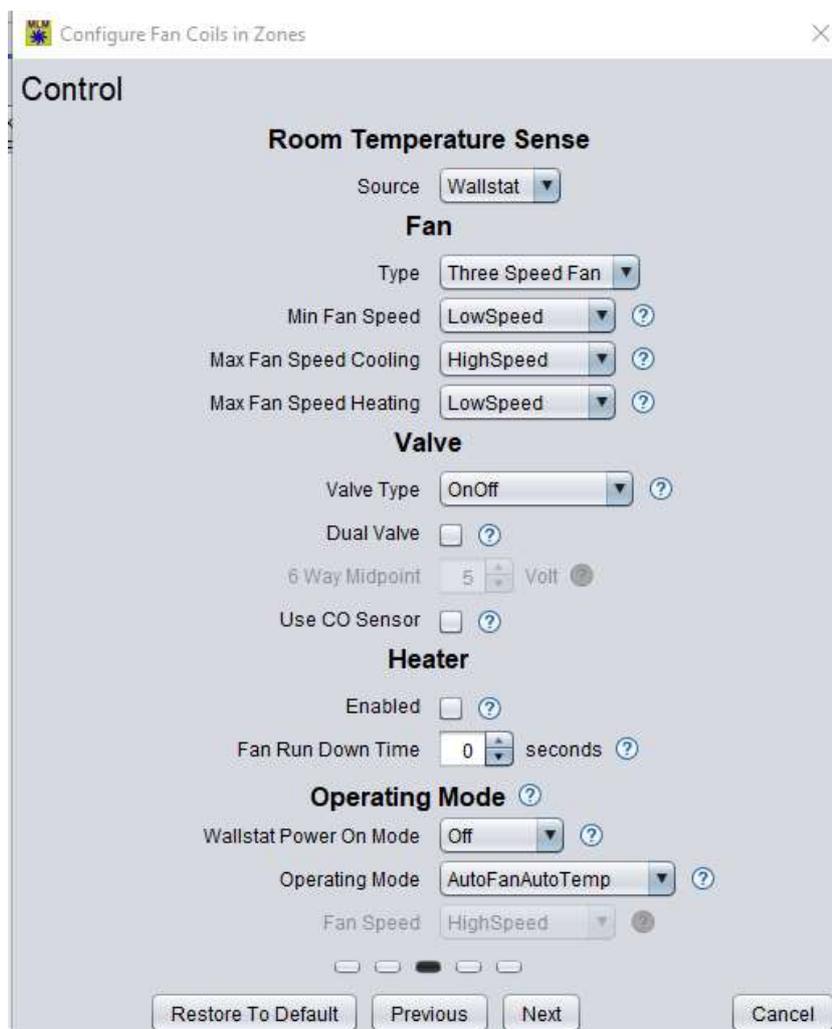


Figure 6: We now select the zones we want to configure and move onto the next page..

This page is where the FCC is set up for the control environment. Hover on the ? icon next to the dropdown tab for a detailed functional description.

- **Room Temperature sense.** Select wallstat or FCC sensor. If a wallstat is not connected the FCC will default to the local on-board temperature sense and a temperature sensor such as the LHA CM6006-2 product needs to be attached.
- **Fan selection** – as indicated.
- **Valve type** – select as indicated.
 - For single valve operation, if a CO sensor is fitted and selected in the wizard, a temperature below 22°C will enable the valve to open in the cooling state of operation and above 22°C be enabled to operate in the heating state.
 - If water temperature sensing is required for dual valve operation, the extra (Inter) sensor needs to be fitted, with the CO sensor for cold water detection and the Inter sensor fitted for warm water detection.
 - The CO selection is also available in the FCC node panel Master Command.
- **Electric Heater** – select if connected. Set the required fan rundown period.



Configure Fan Coils in Zones

Control

Room Temperature Sense

Source: Wallstat

Fan

Type: Three Speed Fan

Min Fan Speed: LowSpeed

Max Fan Speed Cooling: HighSpeed

Max Fan Speed Heating: LowSpeed

Valve

Valve Type: OnOff

Dual Valve:

6 Way Midpoint: 5 Volt

Use CO Sensor:

Heater

Enabled:

Fan Run Down Time: 0 seconds

Operating Mode

Wallstat Power On Mode: Off

Operating Mode: AutoFanAutoTemp

Fan Speed: HighSpeed

Restore To Default Previous Next Cancel

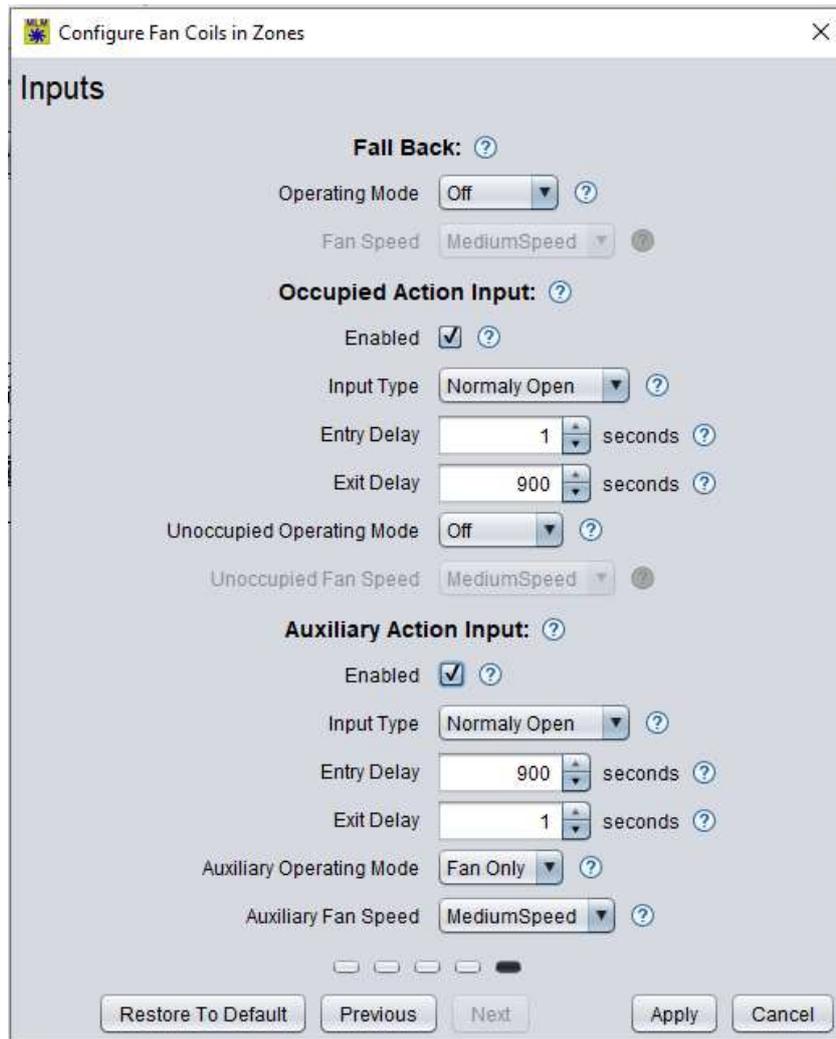
Figure 7: Control setup page

- **Operating Mode**

- If a wallstat is not connected and power is cycled, the FCC will always revert to the Operating Mode it was in before the power was switched off.
- If a wallstat is connected, some duplicate functions will be visible on the mIm Tool node panel on both the FCC and wallstat. In such an instance the wallstat acts as the master node, with only the wallstat functions as displayed in the node panel active. These functions include: Setpoint, Master Command, Fan speed, **Operating Mode** and Power up. This is also applicable to an FCC without a wallstat, but zoned with an FCC connected to a wallstat. As such, only one wallstat is allowed to be connected per zone.
- The Change Over sense select is not available in the wallstat Master Command tab and if in use it must be selected under the FCC Master Command tab.
- Fan speed – if a manual fan Operating Mode is selected (Fan Only or Manual Fan), the Fan Speed box will become active for the user to select the fan speed. This Fan Speed parameter should then be set to equal or less than the 'Max Fan Speed Cooling' parameter under the 'Fan' heading. Note the Fan Speed selection in the mIm Tool or on the wallstat will always be limited by the 'Max Fan Speed Cooling' as set in the wizard.

Select the next page for the fallback, occupancy and auxiliary input setup – see Figure 8

- **Fall-back** – this is the operating mode to fall back on if a connected wallstat is not detected or if the multi-zone mode is selected and the diffuser network not detected.
- **Occupied Action input** – this selection enables occupied/unoccupied operation and is designed to operate with a 3rd party PIR sensor. Note if not in use the occupancy switch inputs should be left open with the 'Enabled' box left unticked.
 - Operation - a standard 3rd party PIR will use a NC contact. Therefore any movement detect will open the contact momentarily to indicate movement. For correct operation connect the FCC occupancy switch wiring to the PIR NC terminals and set the FCC input type to **Normally Open**. Set the entry and exit delays. Default 1 second to switch from unoccupied to occupied and 15 minutes from occupied to unoccupied.
 - Multi-zone - if the diffuser occupancy sense is used in a multi-zone application, occupancy must be enabled in the wizard. With the FCC switch terminals left unconnected, the input type in the wizard must be set as Normally Closed to force unoccupied on the switch terminal side. Once both the occupancy delays as set on the diffuser controller times out it will trigger the whole area as unoccupied. The user can optionally still connect a 3rd party PIR to serve in an OR function with the diffuser occupancy sensors. The NC terminals of the PIR must then be connected to the FCC occupancy input terminals, but now the Input Type must be set to Normally Open.



Configure Fan Coils in Zones

Inputs

Fall Back: ?

Operating Mode: Off ?

Fan Speed: MediumSpeed ?

Occupied Action Input: ?

Enabled: ?

Input Type: Normally Open ?

Entry Delay: 1 seconds ?

Exit Delay: 900 seconds ?

Unoccupied Operating Mode: Off ?

Unoccupied Fan Speed: MediumSpeed ?

Auxiliary Action Input: ?

Enabled: ?

Input Type: Normally Open ?

Entry Delay: 900 seconds ?

Exit Delay: 1 seconds ?

Auxiliary Operating Mode: Fan Only ?

Auxiliary Fan Speed: MediumSpeed ?

Restore To Default Previous Next Apply Cancel

Figure 8: Inputs setup

- **Auxiliary Action Input** – this input function is designed for a level actuated switch as opposed to a momentary PIR switch. When the aux input is switched the FCC will enter the auxiliary operating mode as selected. When selecting between Normally Open and Normally Closed, always consider the external switch position where the FCC should operate 'normally'.
 - Example - for a card switch holder this could be a normally open contact, i.e when the card is inserted in the slot the contact is closed. In this instance the Input Type is set as Normally Closed, as the switch is normally engaged with the card inserted in the slot when the FCC is in a normal Operating Mode. When the card is removed the contact opens to trigger the Aux Operating Mode as selected. The exit delay sets the time delay before entering the Auxiliary Operating Mode after the card is removed. The enter delay sets the time delay before entering the normal Operating Mode once the card is inserted back.

Press 'apply' to finish the wizard setup.

6.5 Post wizard configuration

Once the FCC has been set up by the wizard, there are some operational controls that can be set-up or 'fine-tuned' by the user by means of the node panel. This is useful if individual FCCs need parameter adjustments.

The following command/settings are available under the Process tab:

- Operating Mode – also selected by the wizard.
- Master command – to select the control temperature and setpoint inputs from either the FCC or wallstat.
- Occupancy Override – to force an occupied or unoccupied state. This function is also available as a BMS command input - see Doc DM0073-0021 (BMS BACnet interface to FCC).
- Fan speed – set the fan speed in manual fan operating mode. The fan speed will not exceed the limit as set in the 'Max Fan Speed Cooling' parameter in the setup wizard.

The following settings are available under the Setup tab:

- Control parameters - The proportional (gain) and integral (reset rate) of the internal PI control loop can be adjusted to vary the control loop response time.
- On/Off valve thresholds – should the 220V cooling and/or heating valves be selected, this parameter varies the point at which the PI control loop output activates the valve(s). The default is for 50% on and 10% off.

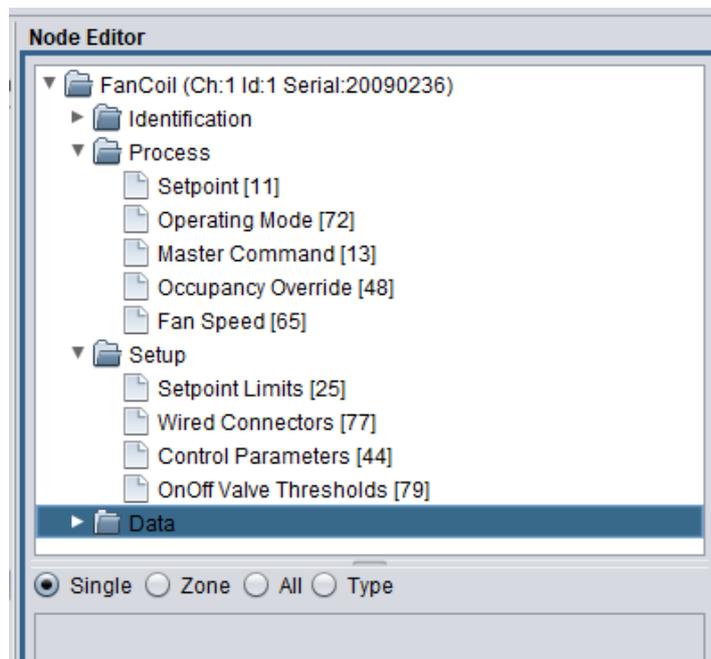


Figure 9: Setup Commands

7 Fan Coil Wallstat

The wallstat serves as a user interface to the FCC, used to alter the operating mode, adjust the fan speed, change the setpoint, display the operating state and temperatures and to power the FCC on or off.

To achieve this functionality the wallstat utilises four side buttons for power, menu, increment and decrement - see in Figure 10. The bottom left button is the power button to turn the FCC on and off. Top left is the menu button. The right hand \pm buttons are used to increment/decrement a specific value on display.

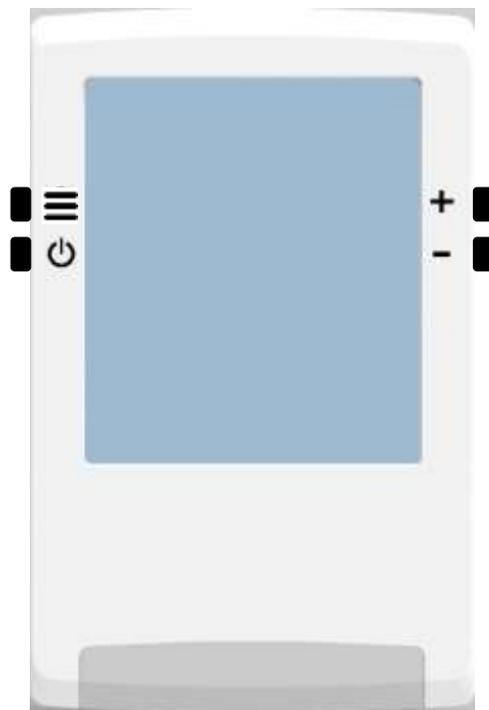


Figure 10: Wallstat buttons

7.1 Wallstat Button Icons

-  - Menu button
-  - Power on/off
-  - Increment
-  - Decrement

7.2 Wallstat Display Icons

The wallstat indicates the current operation of the FCU via various icons displayed on its Liquid Crystal Display (LCD).

The following icons indicate the operational state of the FCC. These icons will always indicate the operating state, regardless of the LCD screen selection.

	Cooling state
	Heating state
	Electric heating
	Area occupied. (Door closed and area occupied)
	Temperature control mode
	Fan is currently operating
	Fan low speed
	Fan medium speed
	Fan high speed

The following icons indicate a non-operational state

	This icon is active when Setpoint edit and display is active
	When the menu display is selected, the fan with border will show
	This icon will activate when a Fall-back state is detected. Fall-back is activated by a diffuser network not detected in multi-zone operation or a previously connected wallstat not detected by the FCC.

7.3 Wallstat Display

The wallstat offers three basic display screens. The Operating State display shows the room temperature as well as heating, cooling etc. The Operating Mode display enables the user to select the FCC Operating Mode. The Setpoint display allows setpoint adjust.

Figure 11 illustrates a typical room temperature display where the current space temperature is 22.3°C, the fan speed is high, the unit is currently in a cooling state and the space occupied. The next figure shows the FCC in heating state, with the heating valve activated and electric heater on.



Figure 11: Room Temperature - Cooling state



Figure 12: Room Temperature – Heating state, Valve and Heater on

7.4 Changing the Operating Mode on the wallstat

The wallstat serves as a user interface to change the FCC Operating Mode. The Operating Mode menu display is indicated by the border icon around the fan. Note the icons showing the current operating state, such as heating and cooling, will still be active while in this display mode.

Mode change – Press Menu to display the current Operating Mode. Press \pm to step through the options. The Operating Mode options will flash on screen. Pressing the Menu button will exit without changing the mode. To enter a new mode selection, simply leave the menu selection to time out. After ten seconds the buzzer will sound and the new Operating Mode will be active.

Herewith below a quick summary of the Operating Mode selection – pictured clockwise from top left:

- **On/Off** - press power button (see end note ¹)
- **Fan only** – press **menu** and \pm buttons for F1, F2, F3 select
- **Full Automatic control** - press **menu** and \pm buttons for AA select
- **Auto (Manual Fan Auto Temp)** - press **menu** and \pm buttons for A1, A2, A3 select

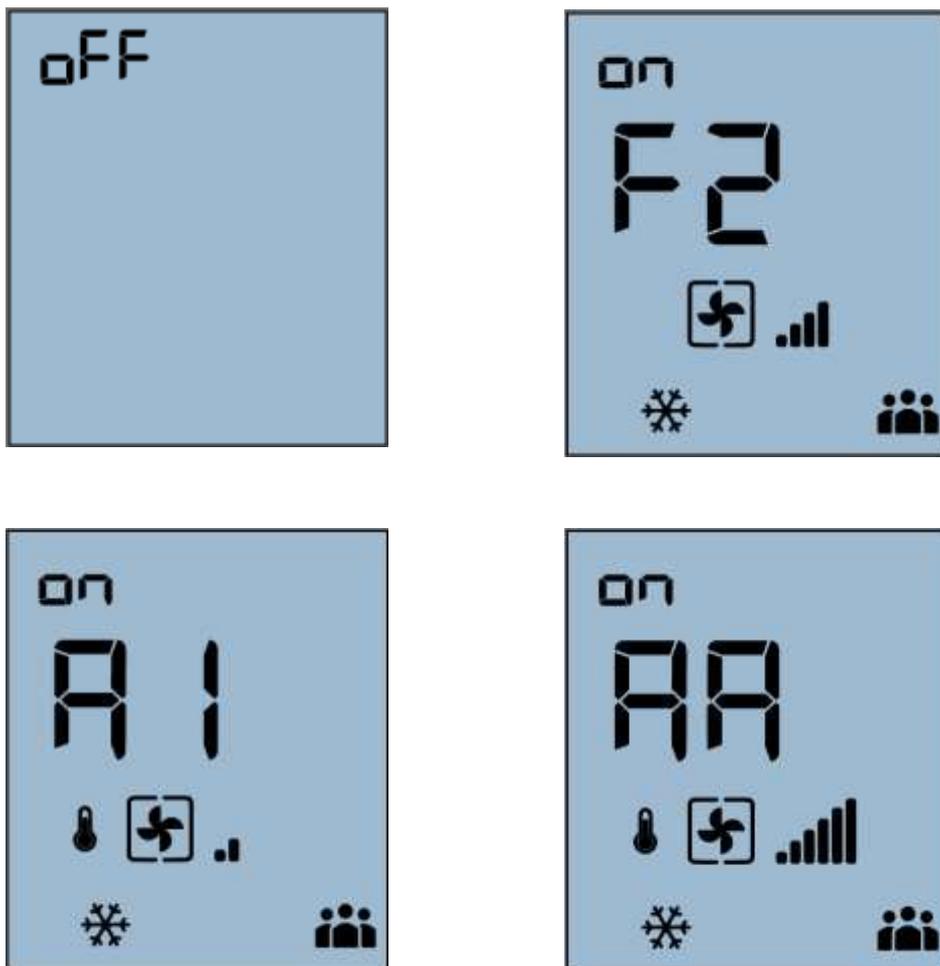


Figure 13: Operating Mode menu

7.5 Wallstat Setpoint adjust

To display the setpoint, press the **+** or **-** buttons. The **SP** icon will show. Press the **+** or **-** buttons to adjust the setpoint. While adjusting the **SP** icon will flash. Once adjusted and no further input from the buttons detected, the wallstat will beep after a timeout period of ten seconds and revert to the room temperature display with the **SP** icon switched off.



Figure 15: Setpoint display

7.6 Unoccupied/Auxiliary/Fall-back display

- An unoccupied condition is detected by PIR inactivity on the occupancy switch input, diffuser network occupancy sense or BMS unoccupied command. The  icon will then switch off. The Unoccupied Operating Mode as selected in the wizard will be active.
- The Auxiliary operation is activated by the Auxiliary switch input. The  icon will flash when this input is activated. The Auxiliary Operating Mode will be active.
- Fall back is active as a result of a diffuser network in multi-zone or a previously connected wallstat not detected. The  icon will flash.

ⁱ The auxiliary input has a higher operating priority than the 'Off' Operation Mode. When the auxiliary input is active the Auxiliary Operating mode will be active, even if the 'Off' Mode is selected.