Ability projects ltd

commissioning guide

MATRIX

ultimate fan coil system

Matrix Commissioning

Overview

The design brief for the most advanced Matrix was for a unit that would self-set its own water flow rates, air volumes and duct balance, removing the need for commissioning in the conventional sense.

However, even with Matrix we appreciate that some level of checking is inevitable, from a few spot checks, to a full sweep of every unit.

Remember, to communicate with many Matrix units is so much simpler with the BMS network robust and in place. Essentially, from any location you will be able to communicate with all the Matrix units that have been networked to the router or switch into which you are physically connected.

The BMS 'Head-End' itself does not need to be installed and working as all the Matrix commands and functions are available through the Ability Engineering Software.

A Word of Advice

From the outset, focus on having the network installed early because a stable network makes everything that Matrix does so much easier and quicker.

A Word of Caution

Matrix demands that standard, basic hydraulic pre-commissioning is completed to a functional standard.

It is very easy to start adjusting fan speeds and valve positions as a result of apparently poor initial commissioning figures. You should avoid this at all costs until every possible cause of the inaccuracy has been fully explored. Matrix does control accurately and preemptive adjustments almost always end up having to be removed once the real problem is identified or, simply, clears itself with time.

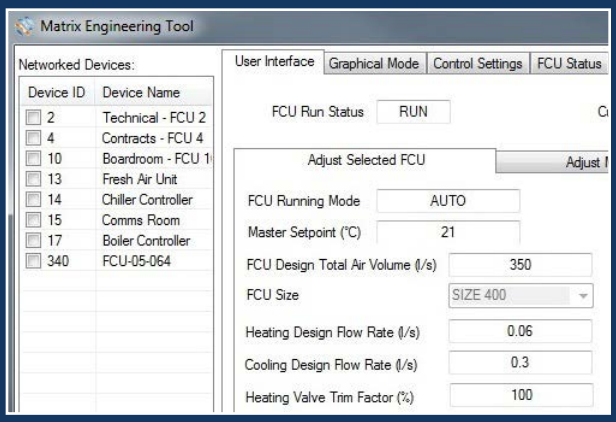
This commissioning guide is only intended to give a superficial overview of the Matrix Engineering Tool. Before using the tool on a live project, please acquaint yourself with the latest full guide which is always available upon request.

Software Tools

Matrix Software Engineering Tool

Every project should have access to its own laptop/ notebook loaded with the Matrix Commissioning Engineering Tool Set. This software package contains all the commissioning and operational routines that make Matrix stand out. The various functions are explained fully in a supplement to this guide. However, the most important commissioning 'states' are summarised here.

Always leave a few minutes after any software change to ensure that the required mode has been fully actioned by the physical unit.



A 'Run Status' or Running Mode' entry field in the Matrix Engineering Tool allows you to change the running mode of the unit or units.

Matrix Commissioning Mode

Matrix 'Commissioning Mode' sets and holds the Matrix valves to their design water flow positions and the Matrix fans to their design speeds and air volumes.

You can put any Matrix into commissioning mode through either the supplied software or by using the physical switch on the underside of the electrical enclosure.

Matrix Flushing Mode

Matrix valves can be disengaged from the actuator if necessary. There is a clutch mechanism on the actuator that can be 'manually latched' meaning that the actuator motor remains disengaged until the clutch is 'manually unlatched'.

In the latched state the unit strategy does not drive the valve. The valve is moved by manually rotating the black handle. Should these clutch buttons be used in any way for any purpose, double check they are all returned to 'Auto', or their unlatched state when you are finished.

If power is available and the network wiring is in place, a 'Flushing Mode' command should be sent to the units instead of manually latching the valves open. This saves time and removes the high probability that some valves will inadvertently be left latched.

Auto

When the valve clutch is disengaged, the black push button is flush with the top of the actuator casing.

Manual

When the valve clutch is engaged, the black push button is not in line with the top of the actuator casing.

Valve Actuator Heads

Do not remove actuator heads for any reason other than replacement! If for any reason you find an actuator removed then you need to carefully follow the reinstatement instructions in the operating and maintenance guide.

Hydraulics with PICC Valves

As with any commissioning routine, the ability of a valve to control to the correct water flow, and the accuracy of any checks made to confirm water flow, depend upon the accuracy of the measuring devices and that the building hydraulic system is in a ready state to be measured.

The most common problems that prevent Matrix returning accurate and repeatable results are:-

- An inadequate hydraulic differential pressure. PICC valves need a differential pressure of at least 35kPa minimum across every valve.
- An inadequate quantity of water being made available to the valve. So often a valve that appears to be delivering too little water is actually being starved by another valve (often a branch regulating device) that has not been fully opened.
- PICC Valves, like every valve, also need the water to be of sufficient quality. This means adequately strained and adequately de-aerated.
- Look also for other valve components left in a 'non-operational' state. Isolating valves left shut, bypasses left open, actuators left in 'manual open override'

For further information on the pre-requisites for successful commissioning, refer to the current CIBSE and BSRIA Guides on the commissioning and pre-commissioning of hydraulic systems.

Firstly - Hysteresis - An Explanation

All pressure independent valves experience 'Hysteresis'.

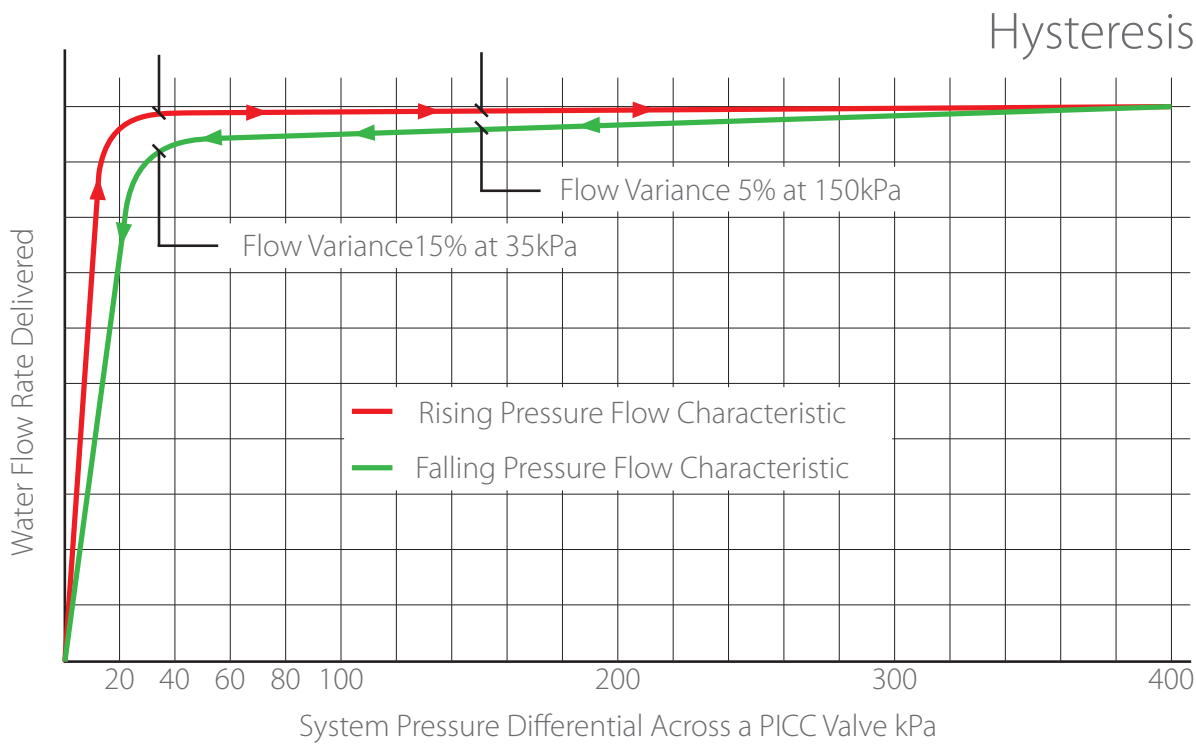
The Hysteresis effect, in PICC valves, is the mechanical lag of the pressure independent cartridge as the system pressure acting upon the cartridge increases or decreases.

PICC Valves return consistently to the same flow position when the pressure against the valve cartridge is rising.

However, if the pressure in the hydraulic system is falling, the hysteresis effect comes into play and the flows become slightly less accurate and less repeatable until the cartridge settles.

You can see from the graph how, particularly at lower pressures, the flow difference between the rising pressure line (Red) and the falling pressure line (Green) for a set valve position is about 15%, as a maximum.

It is therefore paramount that all commissioning and verification processes on PICC valves are conducted on the same curve in a 'rising pressure' situation providing repeatable and reliable readings, unit to unit, day to day!



Commissioning Allowing for Hysteresis

When the pump speed during commissioning is fixed and is not allowed to react normally to pressure changes, it is possible when opening any number of control valves to induce a pressure falling situation and introduce the influence of hysteresis..

To avoid this, the valves should always be driven to their design position (commissioning mode on) before the pumps are switched on. Note, any substantial changes in the position of the valves during commissioning will require the pumps be stopped and restarted or at least slowed and then speeded up.

So, the routine is:-

- Turn pumps off or down
- Put units into commissioning mode
- Turn pumps on or speed them up
- Wait to settle then measure

In normal day to day operation, the Matrix PICC valves gently modulate to satisfy demand and rarely reach their full design water flow position where hysteresis, were it evident, may have an influence.

However, in a well-designed hydraulic system under automatic 'day to day' control, if the thermal demand increases, the unit valves will first open reducing system pressure but then the pump will speed up to compensate for the rise in demand and the pressure will subsequently increase. This means that at any time with the thermal load increasing, to any point and up to peak load, there is no hysteresis and control is accurate and precise.

Hysteresis - A Summary

If the flows initially appear inaccurate or variable, check the system and the validation methodology rigorously before any adjustments are made.

Commissioning Matrix as described will remove the hysteresis effect and accurate and repeatable flow rates will be achieved.

However, in automatic mode, if hysteresis deprives a fan coil of a small percentage of its water allocation, the Matrix 'Boost Mode' will monitor and correct this for as long as the condition exists. Boost mode is described later in the commissioning guide.

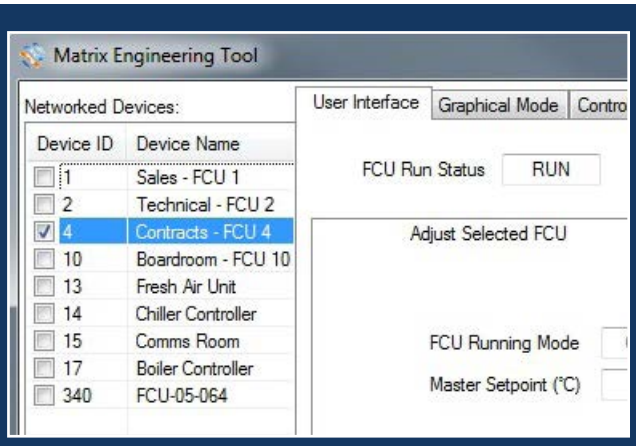
Heating Flow Rates

Heating flow rates are often very small with flows of 0.01 l/s and less not being uncommon. When defining the commissioning tolerances to be applied to the heating flows, be careful that while your percentage tolerance might sound fair, the absolute flow that demands is unrealistically low.

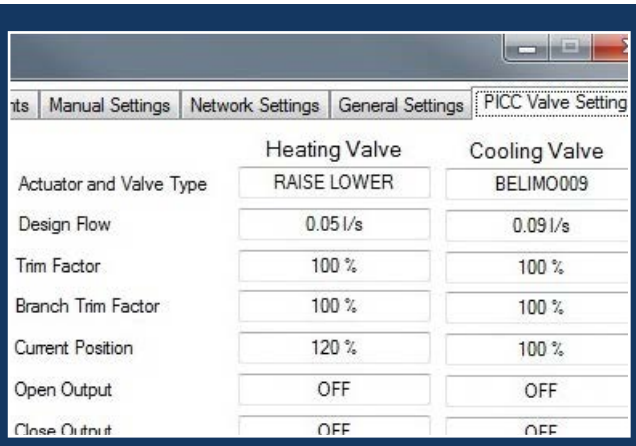
A -0% +20% tolerance on a heating flow of 0.01l/s gives a acceptable flow range of just 0.002 l/s.

Consider, 0.002 l/s is under a half a teaspoon of water per second. This quantity will be outside the controlling capability of any valve and certainly not measurable by any site based, site quality measuring equipment.

Heating flow tolerances are best defined as a percentage but only down to where a minimum, realistic value is reached. EG 20% or 0.005l/s whichever is the greater.



To select a Matrix Unit to interrogate or adjust. 'Select' the unit in the 'Network Device' list and press 'Connect to Device'



Use this screen to adjust the design flow rate values or the adjustment trims of any valve.

Hydraulic Must Haves!

At this point in the commissioning process, measuring is about to start. On the basis that we seek accurate flow control, then the measurements that confirm them need to be equally accurate. To achieve this, certain prerequisites need to have been fulfilled.

All the measurement methods described and the accuracy of the measurements obtained rely upon every PICC valve having available to it :-

- An adequate volume of clean, de aerated water
- A differential pressure across the valve of 35kPa Minimum

Branch Flow Pre Checks

Now there is an adequate volume of clean, deaerated water and a differential pressure across every valve of at least 35kPa, there are two essential branch level checks to perform.

Test One is to confirm that with all the PICC valves closed, the water flow to the branch actually stops. Remember, isolate or close any other products or valves on the branch that might also let water by.
If the flow does not drop to zero, there could be a bypass open, a unit left in commissioning mode or valve actuator left in a manually clutched state - investigate, correct and check again.
Once this 'No Flow' test has been successfully run move on to test two.

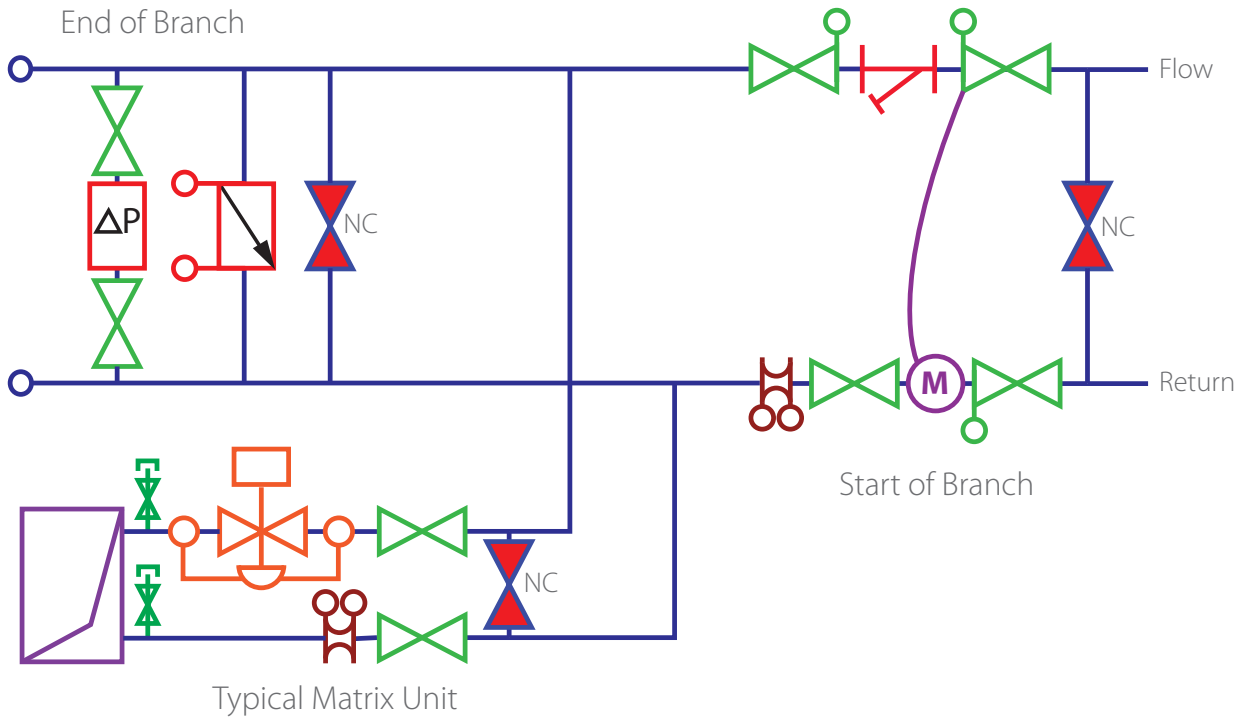
Test Two is to confirm that with all the valves at their design flow positions, the water flow to the branch is roughly equal to the total water requirement of the Matrix units on that branch.

Firstly, ensure all units are on the upper hysteresis curve by following these guidelines:-

- Turn pumps off or down
- Put units into commissioning mode
- Turn pumps on or speed them up
- Wait to settle then measure

With all the units in commissioning mode, connect into the branch measuring station with a manometer. Confirm that the total water flow is at least equal to the sum of the Matrix design flows for the branch. If not, investigate, correct and check again. Some typical problems are:-

- Open bypass valves
- Inadequate system pressure - 35kPa minimum
- Air in the water. Even micro bubbles will give apparently low readings
- Blockages within strainers, branch regulating valves or even the PICC valves themselves
- Other heating/cooling products connected but not calculated in to the total branch volume
- Branch regulating / isolating valves that have been left shut or partly closed



If you experience any problem, correct it first then recheck. Remember the routine:-

- Turn pumps off or down
- Put the units back to Commissioning Mode
- Turn pumps on or speed them up
- Wait to settle then re-measure

Branch Flow Checks Completed

Having now established that the actual total flow matches the scheduled total flow rate for the branch and that the flow stops when all the PICC valves are shut, then it is safe to proceed with any further individual checks required.

Measuring Flow / Balance at the Unit

Even if there are measuring devices on all the Matrix units, it is still best practice to conduct a branch level pre-check to ensure the branch is adequately supplied with water.

Again, confirm that the basic prerequisites have been satisfied, an adequate volume of clean, deaerated water and a differential pressure across the valve of 35kPa Minimum.

Remember also, every time you return to a branch or a valve to recheck it, be it the next day or simply an hour or two later, if the valves have been taken out of commissioning mode or the unit turned off (possibly overnight), you must restart the process:-

- Turn pumps off or down
- Put the units into Commissioning Mode
- Turn pumps on or speed them up
- Wait to settle and only then measure

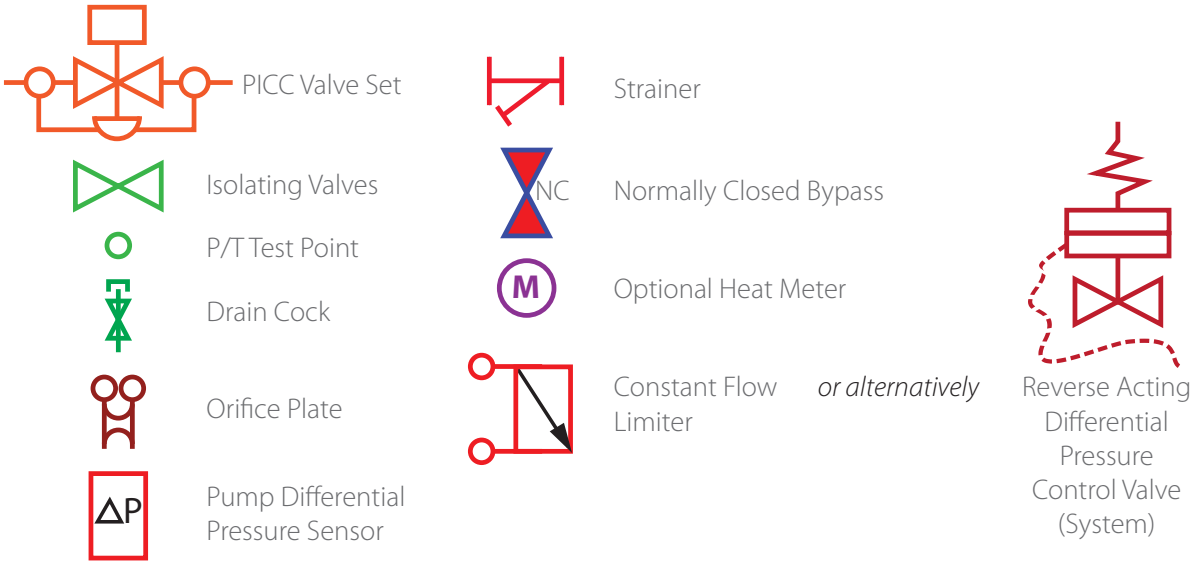
This gets the system back onto the accurate, repeatable and operational upper curve of the valve.

At this point, it should be possible to read and record individual flow rates.

Caution

It is very easy to start adjusting water flow rates as a result of apparently poor initial commissioning figures. You should avoid this at all costs until every possible cause of the inaccuracy has been fully explored and either ruled out or corrected.

Matrix does control accurately and pre-emptive adjustments almost always end up being removed once the real problem is identified or simply clears itself.



Environmental flow check

A simple, alternative method to confirm the correct water balance of a branch of Matrix units is called an Environmental Balance Check.

This method is particularly useful on the heating circuit where water flows are often so small, measuring them accurately by conventional means is virtually impossible.

To put this into perspective, a heating flow rate of 0.01 l/s is two teaspoons of water per second. Trying to measure to a tolerance of -0% +20% of a 'two teaspoons per second' flow using conventional pressure differential flow measurement devices is simply not possible. The orifice device will be outside its performance range, the pressure differential measured will be miniscule and the results therefore will be unreliable.

NB: For the Environmental Check to work properly, the return air sensors have to remain in their original position, ie. in the return air path inside the Matrix unit between the filter and the coil.

Assuming the total flow to the branch has been established and checked, the environmental check uses airside temperature difference to confirm that the total flow to the branch is balanced across the Matrix units on the branch.

If the difference between the return air and the supply air temperatures are reasonably equal, then each unit will be providing kW and the units on the branch will be balanced. If there are any units that fall outside the temperature range pattern for the branch under test, they should be investigated.

Remember, if the branch has been taken out of commissioning mode or the units turned off since the total branch water flow was checked then:

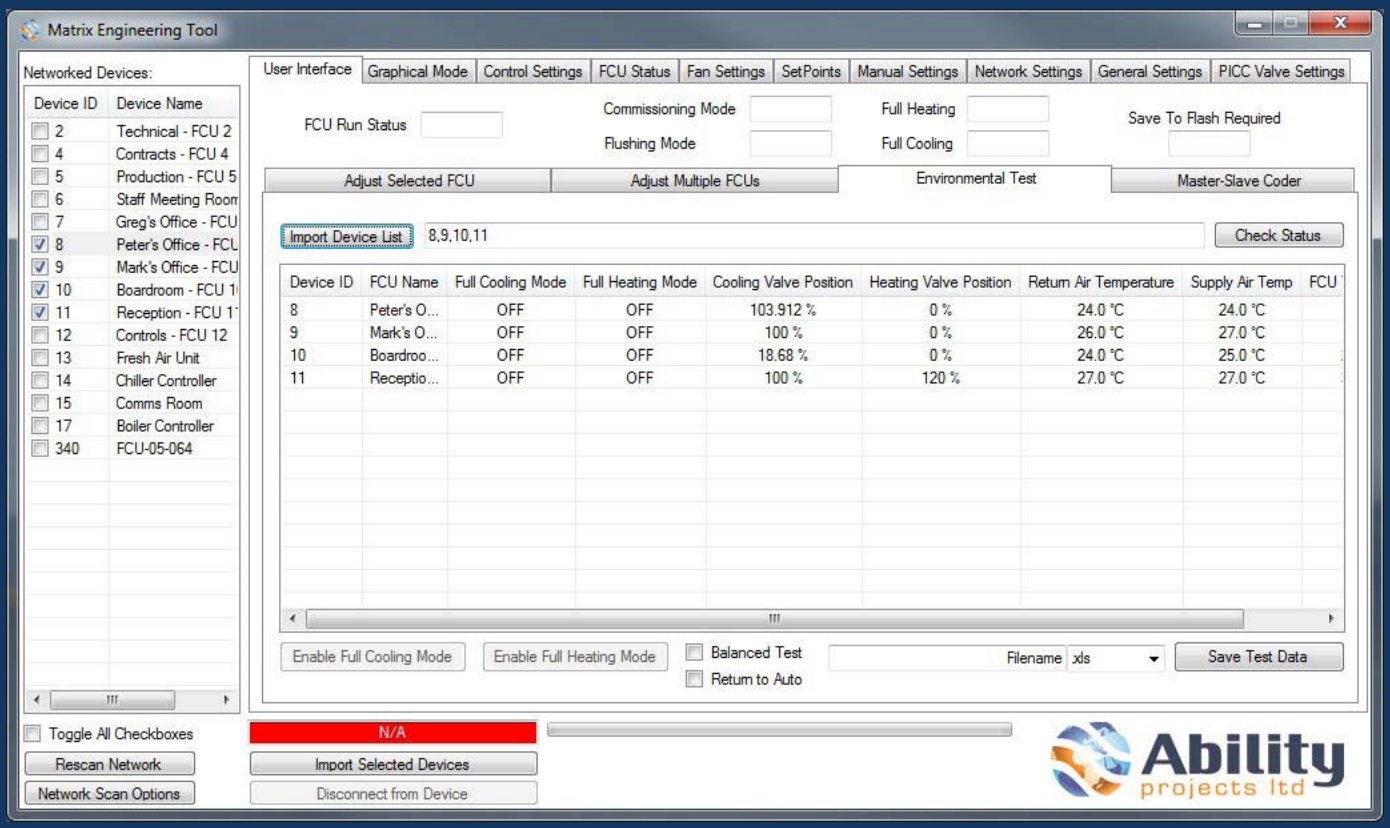
- Turn pumps off or down
- Put the units back to Commissioning Mode
- Turn pumps on or speed them up
- Wait to settle then measure

While this temperature difference check is far simpler and quicker than conventional measurement methods, it does require the chillers (or boilers) are on, even if they are not at the right temperatures.

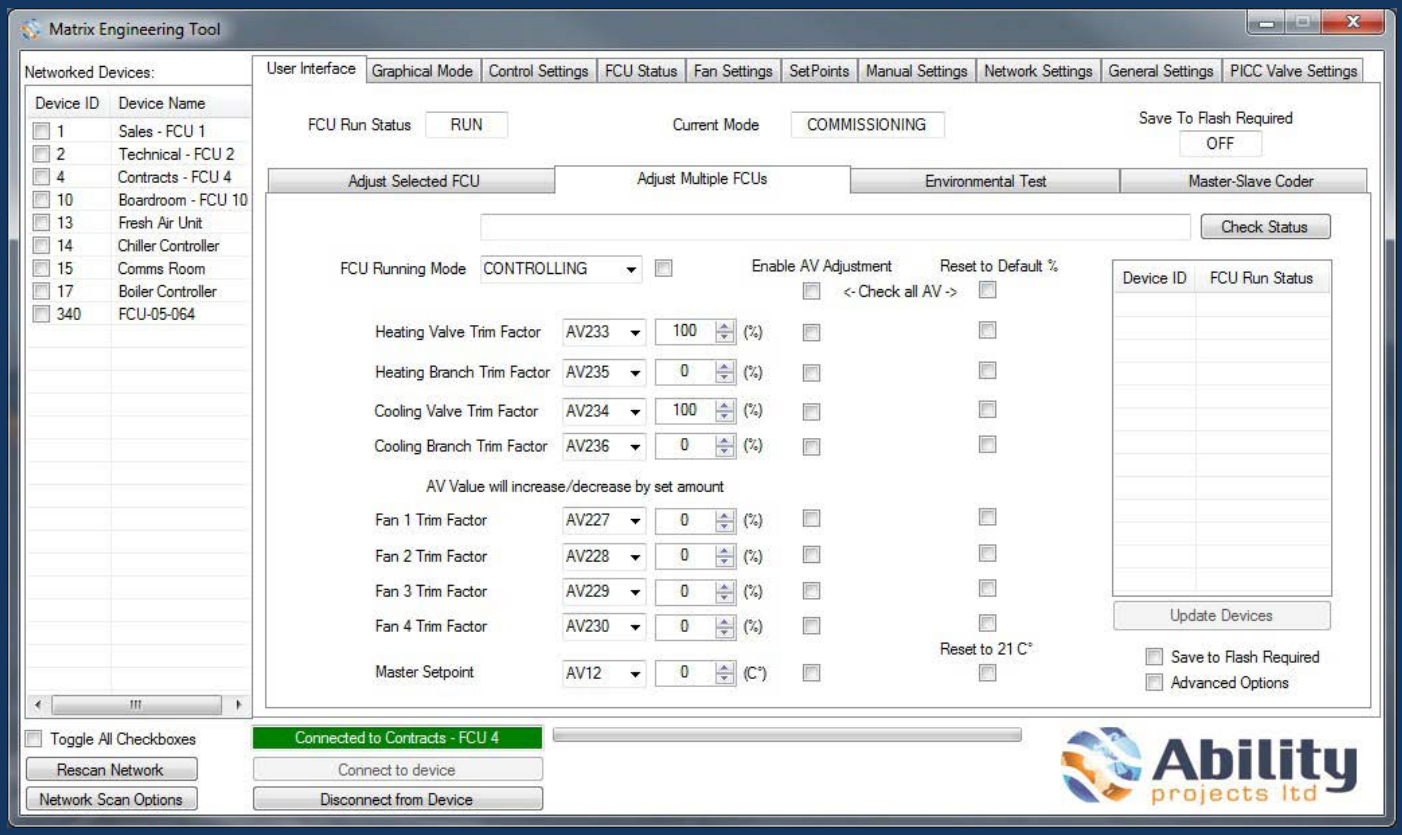
This test can be used on the cooling side as well as heating.

This test is very useful to run even if you intend to measure conventionally. This is because the temperature differences across the coils in both heating and cooling are a very versatile diagnostic tool to pre check the system and find any pre commissioning errors or oversights.

Recognising that measuring 'very low flows' by conventional means is problematic, the latest CIBSE Guidelines approve 'temperature difference' methods for checking and qualifying flow and balance.



Environmental Test 'Select' the units to be tested from the 'Network Device list' > select 'Import Device List' and the results will flow into the table. Options on the test type can be selected at the bottom of the screen.



Making Changes to Multiple Units. 'Select' each device required > select 'Import Selected Devices' to put them in the Device ID selection box > select 'Check Status' to confirm communication > tick the AV's you want to adjust > enter the new AV values and then 'Update devices'.

You will note that if anything goes wrong, you can return your Matrix units to their original settings by 'selecting' the 'Reset to Default' boxes > and finally, select 'Update Devices'.

Boost Safety

Every Matrix, in fact every air conditioning product is judged on its ability to provide a comfortable environment within the design temperature boundaries and with the required noise level.

The Boost Safety routine is a standard safety strategy that monitors each Matrix unit performance in terms of keeping the environmental temperature as the designers envisaged.

There are a number of reasons why the temperature may drift:

- Poor water temperature at the boundaries of the hydraulic system
- A temporary increase in the load
- A unit failure somewhere increasing the demand on the remaining units.
- An incorrect / low measurement of the water flow at commissioning
- The hysteresis effect limiting peak water flow
- A real sensible load which turns out to be higher than the specified design value

How Does Boost Safety Work?

With the valves at design water flow and the air volume at 100%, if the temperature in the space continues to drift away from setpoint, then this is a job for 'Boost Mode'.

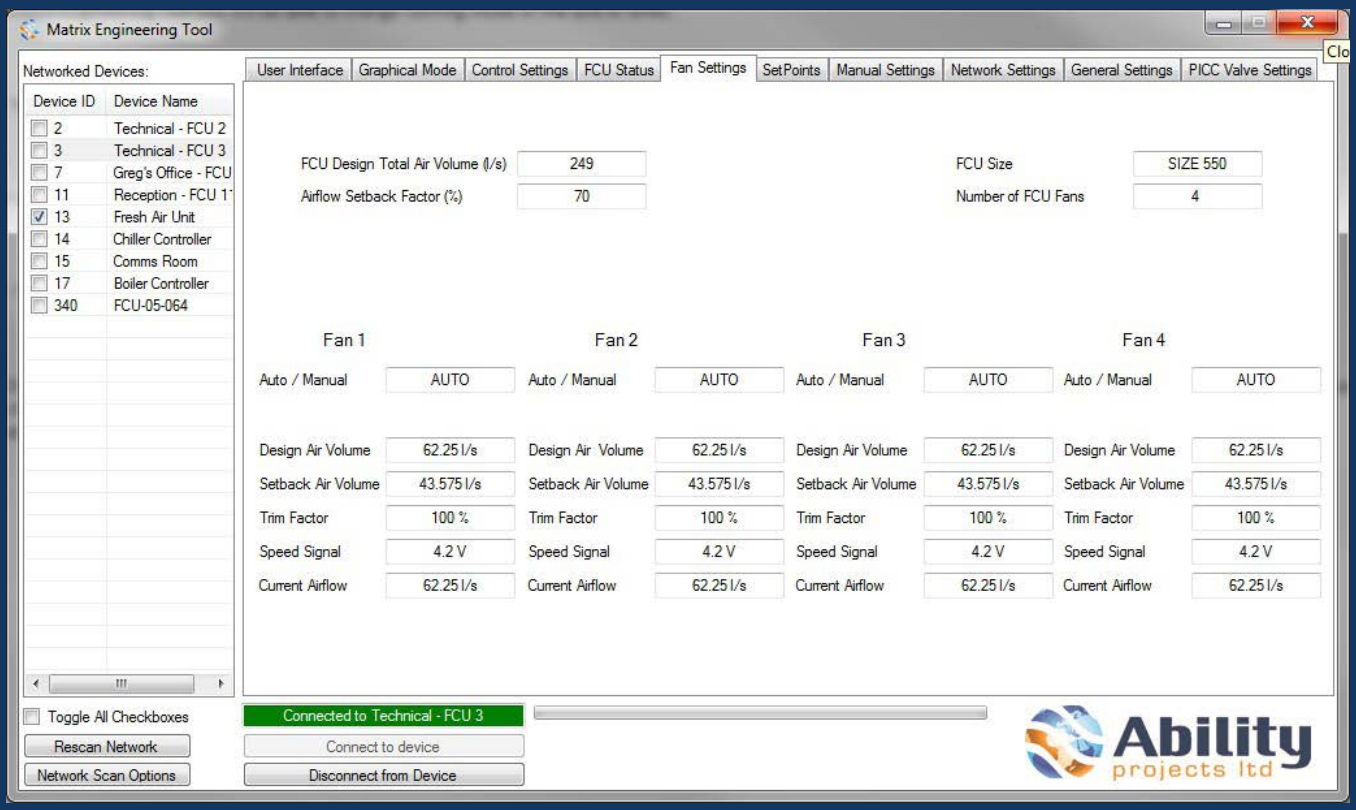
However the situation was created, Boost Mode does not care, it corrects the duty shortfall.

Boost Mode monitors any temperature drift and, if necessary, triggers a temporary relaxation of the design flow rate position. This extra valve opening (15% max) is progressively applied (proportional control) and is only permitted while the shortfall exists.

At all times and for peace of mind, the supply air protection loop monitors events and overrides the Boost routine if the extra flow threatens to induce an undesirable air off condition.

This routine works on both heating and cooling.

If you suspect a small water shortage, if you run out of time to fully test every unit or if you don't want to test every unit, you can be assured that Boost mode will keep the environment within the acceptable, defined boundaries the designer was looking for.



To Adjust the Fans, or any Single Fan in any Matrix Unit

To adjust multiple Matrix units, go to > Matrix Eng Tool > User Interface > Adjust Multiple FCU

Commissioning Non Self Setting EC/DC Fans

These EC/DC fans provide a Matrix where the individual fan speed adjustments, necessary for air volume setting and duct balancing, are made through the Engineering Tool provided as part of the package.

In this instance, the commissioning team would still use a Balometer over the grilles but instead of adjusting a physical VCD to effect balance, they would access and adjust the fan speed of each fan through the software supplied.

If there are a number of units with the same installation style, then the fan speeds settings from the first fan coil can be copied to many others saving considerable time.

A Word of Caution

The signal voltage to provide a normal, office type air volume will be around 5 to 6.5V, never more than 7 Volts. If you are having to send signal voltages of above 7 volts and are still short of air, do not continue increasing the voltage as you will not correct the shortfall but you will create a noise issue. Simply search for the inevitable duct leak, check the balometer seal or revisit your balometer correction factor calculations.

Commissioning Self Balancing Fans

The self balancing fan sets do not need commissioning – they are very accurate!

Provided the correct air volumes have been assigned in the control strategy the fans will deliver the correct air volume to the grille.

However, whilst the fans will self adjust to deal with variances in duct static pressures up to around 50Pa, they cannot compensate for:-

- Leaks in the ductwork
- Balometers that are not adequately sealed or correctly aligned to the active section of the grille
- Incorrect balometer factors

So, if the air volumes appear low then search for these factors first.

Remember, if you have 'swirl style' grilles, balometers must be used with a flow straightening adaptor. Seek advice from the manufacturers of your balometer, they should have a flow straightener or flow conditioner as a standard accessory.

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