



installation guide

MATRIX

ultimate fan coil system

Installation Guide

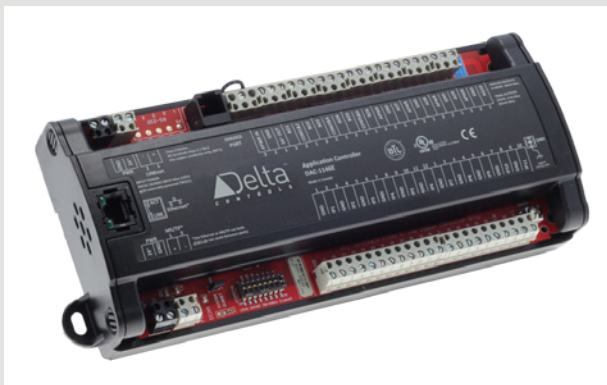
General Notes

This is the Matrix Installation Guide which should be read in conjunction with the Commissioning guide, the 'Quick Start' guide and the Operating and Maintenance Instructions.

An Important Point - Power Surges!

All EC/DC motors are susceptible to damage from power surges. Do not connect your Matrix EC/DC units to any supply if there is any chance that a power surge may occur. Generators should be a cause for concern and carefully monitored.

Networking Options



By default, your controller will have been configured to operate with either a BACnet over Ethernet or a BACnet over IP network protocol.

An MS/TP network requires that MAC address and Network numbers be set into the controller and this will not have been done at the factory if it was not requested.

If an MS/TP network style is required but was not ordered, MAC addresses can be set by adjusting the DIP switches on each unit controller and Network numbers can be retrospectively added using the Software Engineering Tools.

Power Factor Correction

Power factor correction of individual Matrix units is not necessary. There will be many items of electrical equipment on every project with various power factors and the Matrix units are likely to be a comparatively small influence compared to items such as the lighting and computers.

The need for, and the level of power factor correction should be evaluated and applied at a building level. This is because some of the contributing loads will, to varying degrees, cancel each other out depending on whether they are a resistive, an inductive (lagging) or a capacitive (leading) load.

For further information please refer to Engineering Recommendation G5/4-1 October 2005, which considers the connection of non linear loads to electrical supplies.

General Installation

Electrical

By default, your Matrix unit will have been matched to your local electrical supply but it is worth double checking your first unit to be sure. Matrix units generally only require power (live, neutral & earth) and a network connection. If other ancillaries have been ordered then you should request a project specific wiring diagram from Ability if you do not already have one.

Power surges. EC/DC motors are very susceptible to damage from power surges. Do not connect your Matrix EC/DC units to any supply if there is any chance that a power surge may occur.

Matrix Location

Avoid locating Matrix units with the air intake section directly over intake grilles.

Avoid locating matrix units over partition walls or fixed services / pipe work. Doing so may make access very difficult.

Ongoing Access

All air conditioning products, Matrix included, require regular maintenance. Filters, fans and coils will need periodic cleaning to maintain their correct level of performance. It is therefore very important to leave adequate space around the access areas of every Matrix unit to keep maintenance as easy as it can be.

Condensate Connections

The condensate connection is delicate and should be treated with care. The connection between the condensate tail and the main drainage system should be made using a "nonpermanent" fitting. Periodic removal of the condensate tray will be required for coil inspection and cleaning.

Matrix Level

Matrix units incorporate an open condensate collection tray. To ensure the condensate collected in this tray flows away efficiently and does not overflow, the unit should be level.

Given the opportunity, the unit can be sloped slightly towards the condensate drain end which will assist the flow. 2 or 3 degrees is enough, any more might create as many problems as it solves.

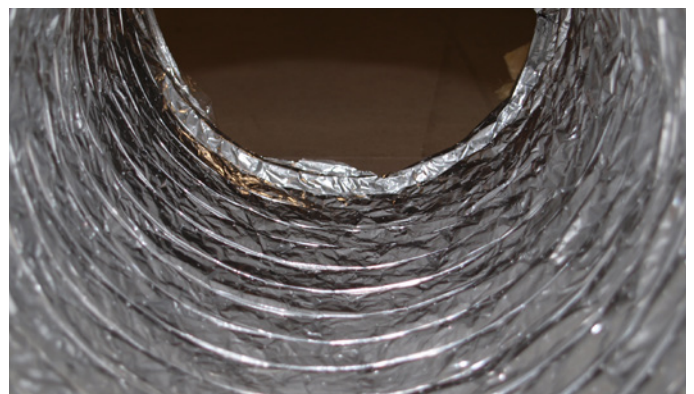
Ductwork

Specifically with Matrix, you MUST NOT block off any active spigot without taking special precautions. More details are available later in this document.

All Matrix units are selected to perform against a maximum duct resistance. Inadvertently increasing this resistance beyond the capability of the unit will have performance implications. The air volumes will fall, the kW output will reduce, the fan speed will increase, the unit will become noisier and the balance between ducts may be upset.

To avoid this risk, flexible ductwork must be installed carefully. Avoid tight bends, keep the ducts as straight as is reasonably possible and avoid squeezing ducts under or around obstructions. Lastly, do not use a greater length of duct than is required.

Ductborne air turbulence created through poor ductwork reduces air volumes, wastes energy and generates noise.



Networking Options

By default, your controller will have been configured to operate with either a BACnet over Ethernet or a BACnet over IP network protocol, not BACnet MS/TP.

An MS/TP network requires that MAC address and Network numbers be set into the controller and this will not have been done at the factory if it was not specifically requested.

If an MS/TP network is required but was not ordered, MAC addresses can be set by physically setting the DIP switches at each unit and Network numbers can be retrospectively applied using the Software Engineering Tool. However, this would have to be done on site, unit by unit. Please seek advice before starting any work in this respect.

The Delta DAC1146E controller supports BACnet over Ethernet, IP and MS/TP.

With a DAC1146E the choice of networking style is yours, however, there are some important considerations in making an informed decision.

The early setting up of Matrix depends upon (or is at least greatly enhanced by) having substantial sections of the building network complete and stable. One drawback with MS/TP is that MS/TP is 'all or nothing'. If any part of the network fails the commissioning teams will lose access to everything, and until an area is complete, they will have access to nothing!

MS/TP is similar to older style Christmas tree lights, if 'one bulb blows you have lost the lot'!

BACnet MS/TP networks require routers at various points to collect and relay information back to the BMS. The selection of router is very important. There are a number of manufacturer's models but all have limitations, most notably the number of devices (controllers) they can handle.

Do not 'overcrowd' any router to try and save money, this will always prove a false economy leading to more 'down time' and frustration as commissioning progresses.

BACnet over Ethernet and BACnet over IP will both appear to involve a lot more wire length, but the wire itself is considerably cheaper, there is less skill required to install it and the system once installed is far more robust and has far more capacity for future development and expansion.

With BACnet over Ethernet or IP, once the first network connection has been made to the first Matrix unit, communication can immediately start and the set up process can begin. Subsequently, when you have connected five units, you will be able to communicate with those five units - you will not have to wait until the whole trunk / floor is networked.

As important is the fact that if someone inadvertently damages an Ethernet or IP network cable, they will only lose communication with the one Matrix unit affected, not the whole building.

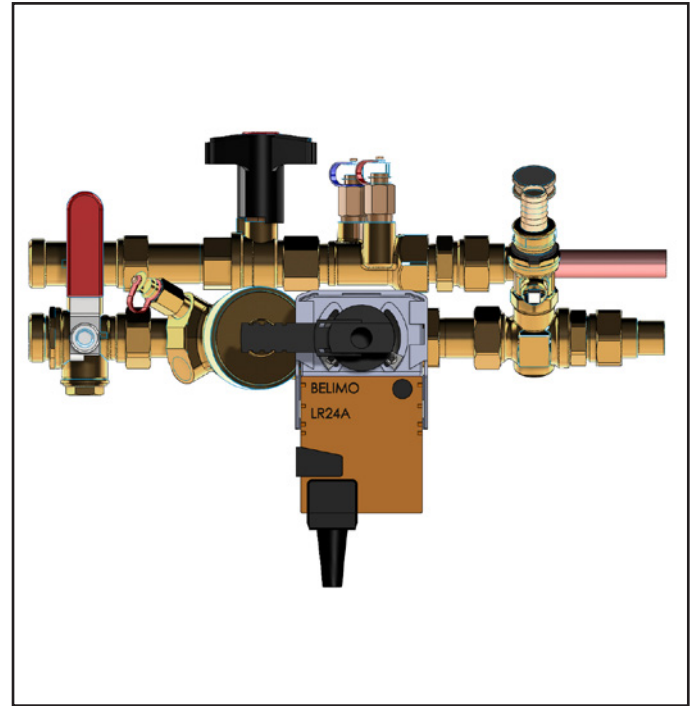
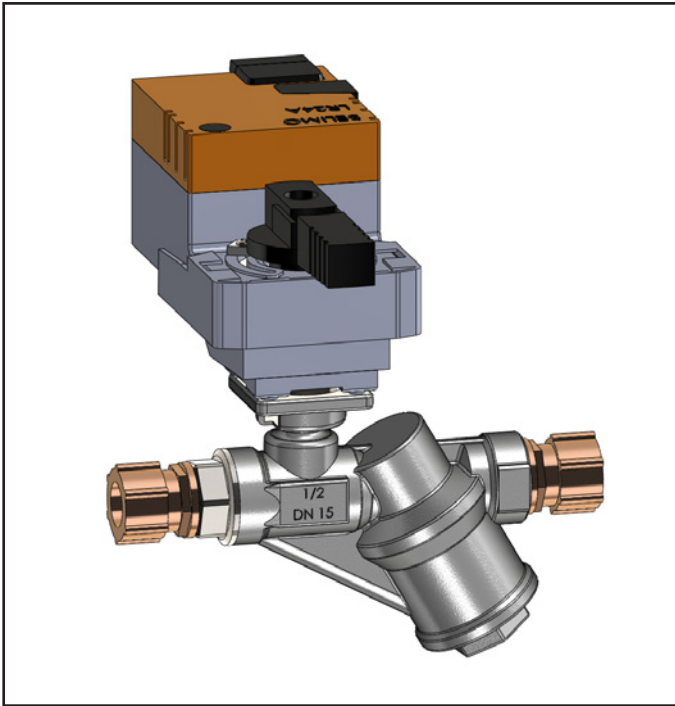
One Last Consideration

Once commissioning is complete and the building is handed over, BACnet over Ethernet and BACnet over IP are both far more robust and support far more communication traffic and at far greater speeds. This leaves the way open for additional equipment to be added, software upgrades, better and speedier energy reporting etc.

It also makes Soft Landings (a progressive handover) far more practical.



**Soft Landing
Friendly**



Hydraulics - The Must Haves !

The aim of the Matrix PICC valve sets is to provide accurate water flow control.

Accurate flow control, the measurement methods described in the commissioning guide, and the accuracy of the measurements obtained all rely upon every PICC valve having three conditions present :-

An adequate volume of clean, de aerated water at a differential pressure across the valve of 35kPa minimum.

Quality, Quantity and Pressure!



This installation document gives guidance to achieve this because if these three prerequisites are not provided, the PICC valves will not work and the flow rate control will be inaccurate and variable.

PICC Valves Within the Pipework System

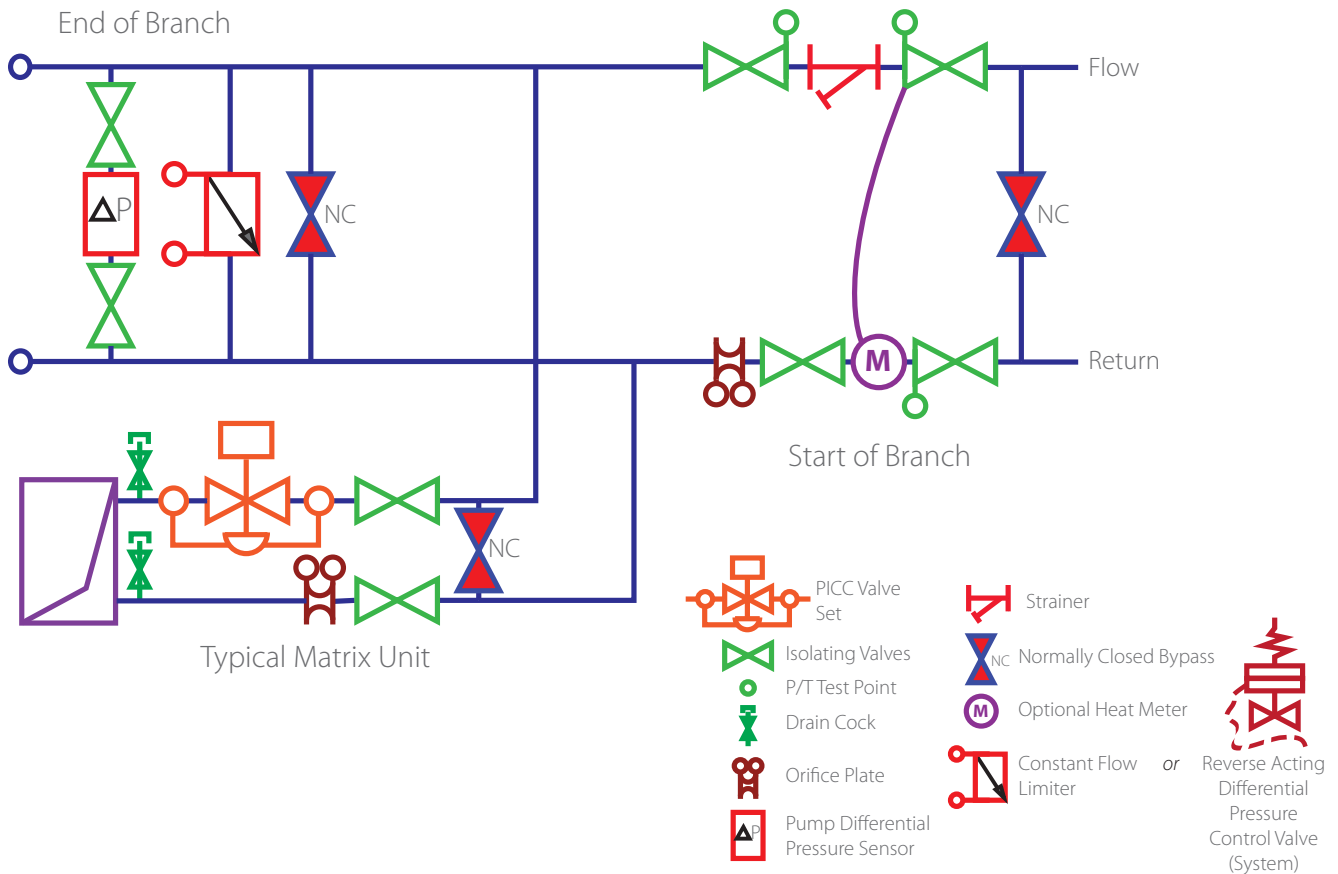
Matrix units fitted with PICC valves should be connected into the building pipe work system in the conventional way with the PICC valve on the flow connection side.

There is no need for any other form of water flow setting or regulating valve at the unit or branch level, only a means of isolation if the package supplied with your Matrix does not already include one.

If your specification defines that flow rate measurement at a unit level is wanted, then you need to ensure the measuring devices chosen are installed in line with the manufacturer's instructions and the latest building codes.

To perform accurately and with repeatability, PICC valves need to be constantly operating within the manufacturer's hydraulic pressure range. As a rule, for most PICC valves this will be between 35kPa and 350kPa. The higher the differential pressure, the more accurate the PICC valves become.

If any units are likely to experience over 350kPa, some form of additional pressure regulation or pressure relief system should be incorporated in the pipe work runs.



Hydraulic Pressure

To ensure the pressure differential across the PICC valves in any system is adequate, you should check the pressure across the end of the hydraulic index leg because, if the pressure here is satisfactory, then the pressure should be adequate at all other Matrix locations.

Setting Pump Speed

For these first steps, leave the pump off.

- Confirm that your system pressure relief device is installed, operational and correctly sized.
- Put the fan coil units into 'Commissioning Mode'. This opens all the PICC valves to their design water flow position. (Refer to the commissioning document for details on activating Commissioning Mode)

Other devices on the same hydraulic branch such as heater batteries, radiant panels, over doors heaters etc should be opened to their design flow positions and included in your pump speed setting exercise.

- Now, turn the pump on.
- Adjust the pump speed until the system establishes the required minimum pressure, which should be at least 35kPa differential at the index PICC Valve.
- Set this speed as the design pump speed to ensure that at all times, at least 35kPa differential will be provided to the furthest Matrix unit.
- If your pump pressure sensor cannot be at the preferred location; the index point, record the pressure at the sensors actual location when the index point pressure differential (as checked by other means) is at least 35kPa. Then, use this value as the design pump speed / pressure.
- At this point it is an idea to close all PICC valves to ensure that your pressure relief mechanism works properly.

NB: In commissioning mode, the fan speed will climb to the design level, this is a normal part of the strategy and does not affect these hydraulic checks in any way.

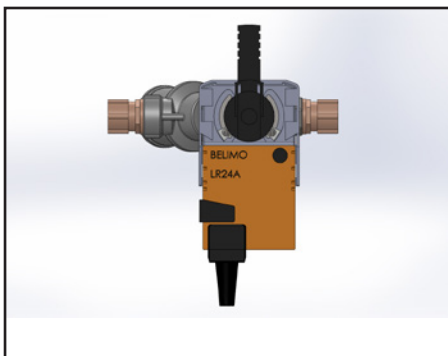
The PICC Valves

There are a number of differences between Matrix and a conventionally styled fan coil type product.

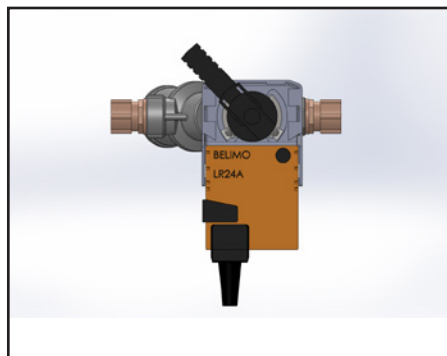
Matrix has a single heat exchange block with two separate circuits, one for LPHW, one for CHW. The PICC valves are 'flow direction' dependant so it is very important to pipe the flow and return correctly and not in reverse; the PICC Valve should be on the flow.

As they arrive, each Matrix will most likely have its valves fully open which in virtually every instance will mean they will initially let by more water than their design flow volume.

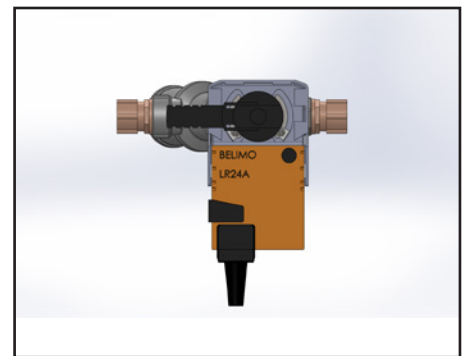
Only after being powered up and put into commissioning mode will they drive to their predefined flow positions allowing water flow rates to be checked.



Valve Fully Closed



Valve Part Open / Auto

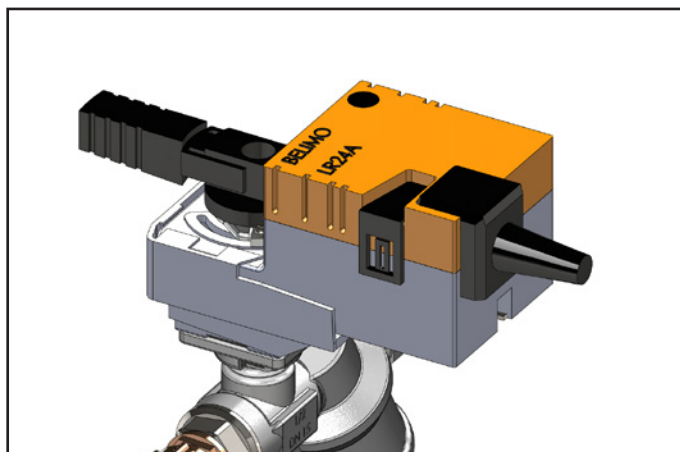


Valve Fully Open / Flushing

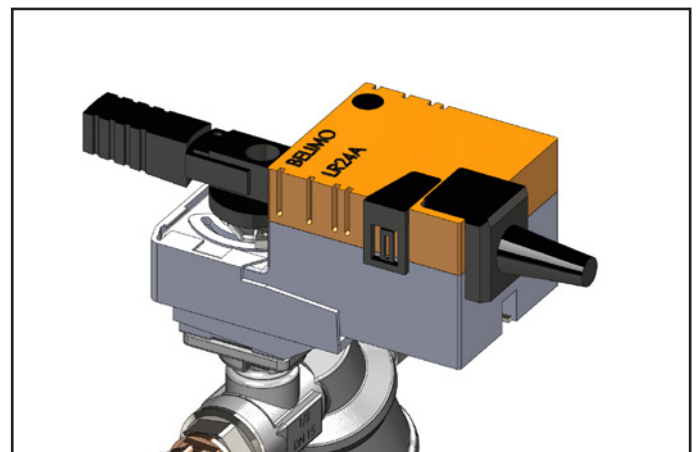
For the purposes of flushing and diagnostics, the valve actuators have a manual clutch that can be used to disengage the actuator motor and allow the valve to be open and closed by hand. However, if you use the manual clutch for whatever reason, make sure it is returned to automatic before commissioning starts.

Flushing mode and the manual clutch are described more fully in the Commissioning Guide.

Apart from replacing breakages, do not remove the actuators from the valve bodies



Actuator Manually Latched



Valve Under Auto Control

Network Installation - BACnet MS/TP

Please ensure your network conforms to the standard MS/TP BACnet guidelines as full network functionality will be compromised if all of the recommendations are not followed.

- The networking cable recommended is Belden 9841 cable or an equivalent that has identical electrical characteristics. Do not risk using inferior cable because cable types suitable for other protocols are most often unsuitable for BACnet MS/TP.
- In order to take full advantage of all the benefits of Matrix the MS/TP BACnet network should run at a baud rate of 76.8K. This is higher than that used by some other networking standards and is the reason the system requires a low capacitance cable to work properly.
- The entirety of the network should use the same cable. Other products or Panels that arrive on site pre-wired should also have any parts expected to carry MS/TP wired with the same Belden 9841 or the equivalent.
- BACnet MS/TP should only ever be wired daisy chain style in a strict linear topology; there must be no sub spurs or branches.

Proper network shielding is vital to proper network functionality. The shield of the cable coming from one controller should be linked to the shield of the cable going to the next controller within each Matrix electrical enclosure.

The cable sheath should be stripped back no more than 25mm. This keeps the total length of unshielded cable on the whole network to an absolute minimum.

The shielding connection must be electrically insulated from contacting any other item in the electrical enclosure.

Finally, the cable shield from each trunk should be grounded but in one location only. The best place is in the enclosure or panel housing the router.

Every MS/TP network trunk must be terminated with a 120 Ohm resistor wired between the positive and negative terminals on the last device on every network trunk. This will be at the opposite end of the daisy chain from the router.

Every router installed will also need a terminating resistor wired across the positive and Negative terminals (120 Ohm) if it does not have one built in.

Pay careful attention to which Delta controller terminals the Belden 9841 MS/TP network is wired to. The correct terminals are labelled "NET 1" which are intended only for BACnet MS/TP.

The controller terminals labelled "NET 2" are for smaller proprietary networks and for devices such as digital room stats. If NET 2 terminals are used inadvertently on any Matrix unit within the building, not only will that unit be unable to communicate but the entire network and/or branch will fail.

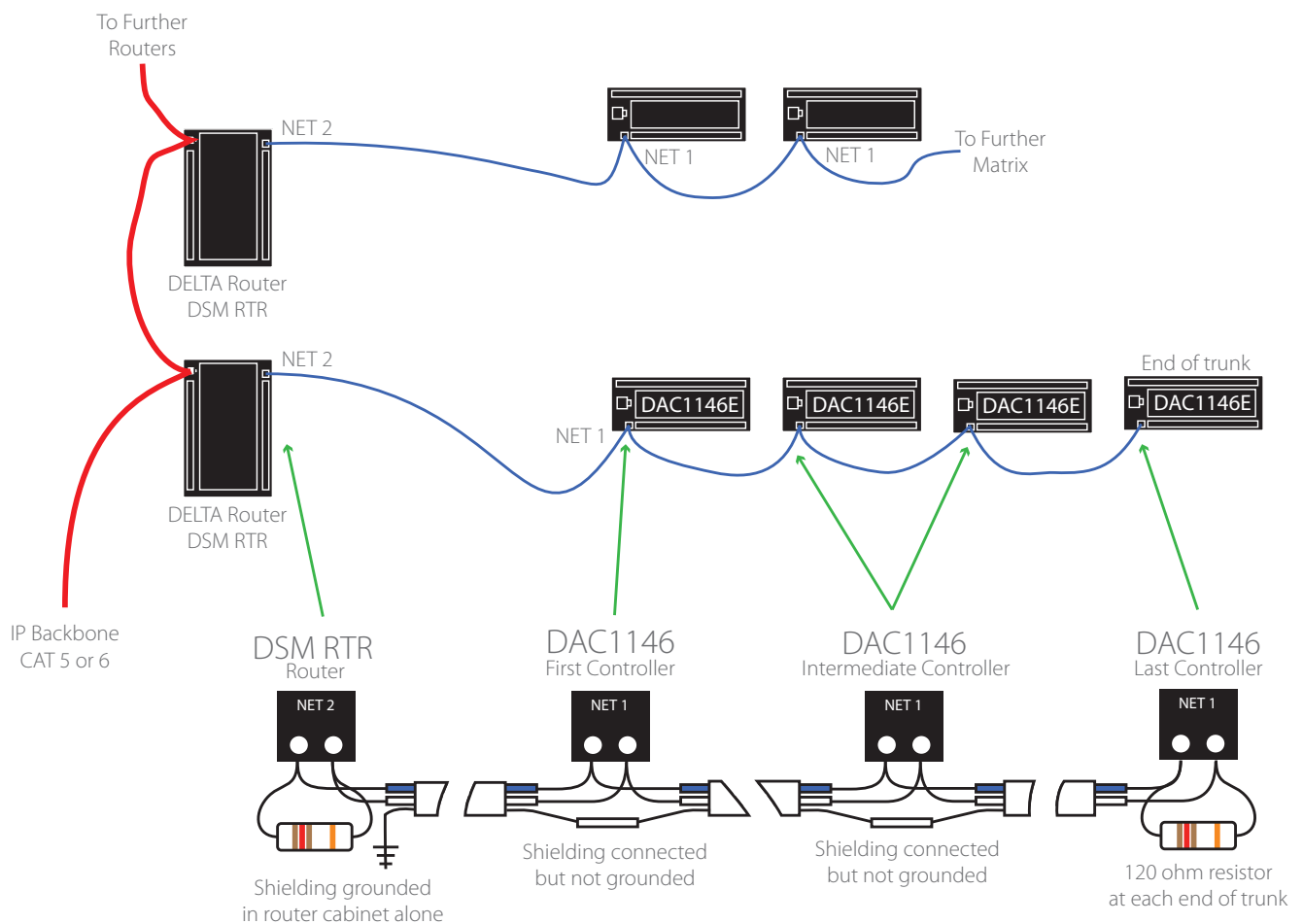
MS/TP Network cabling should never share cable trays with mains cabling and should avoid any other strong sources of interference.

Proper network functionality is central to the commissioning procedure for Matrix. If the guidelines are followed the chances of failure are minimised.

Golden Rules

- Use the correct cable only
- Strip back sheathing as little as possible, 25mm Maximum
- Strictly network 'unit to unit' only
- No sub trunks or spurs
- Use 'NET 1' controller terminal for networking
- 120 Ohm resistor at both ends of every trunk
- Earth / ground each trunk cable once only
- Keep network cabling away from power cabling

MS/TP Network



Delta Router DSM - RTR

If Delta routers have been purchased, these should accept the MS/TP trunk into the NET 2, not NET 1.

The maximum number of DAC controllers on any trunk incorporating a Delta Router is calculated using this simple formula.

So as an example, if your point count was the following eight items:-

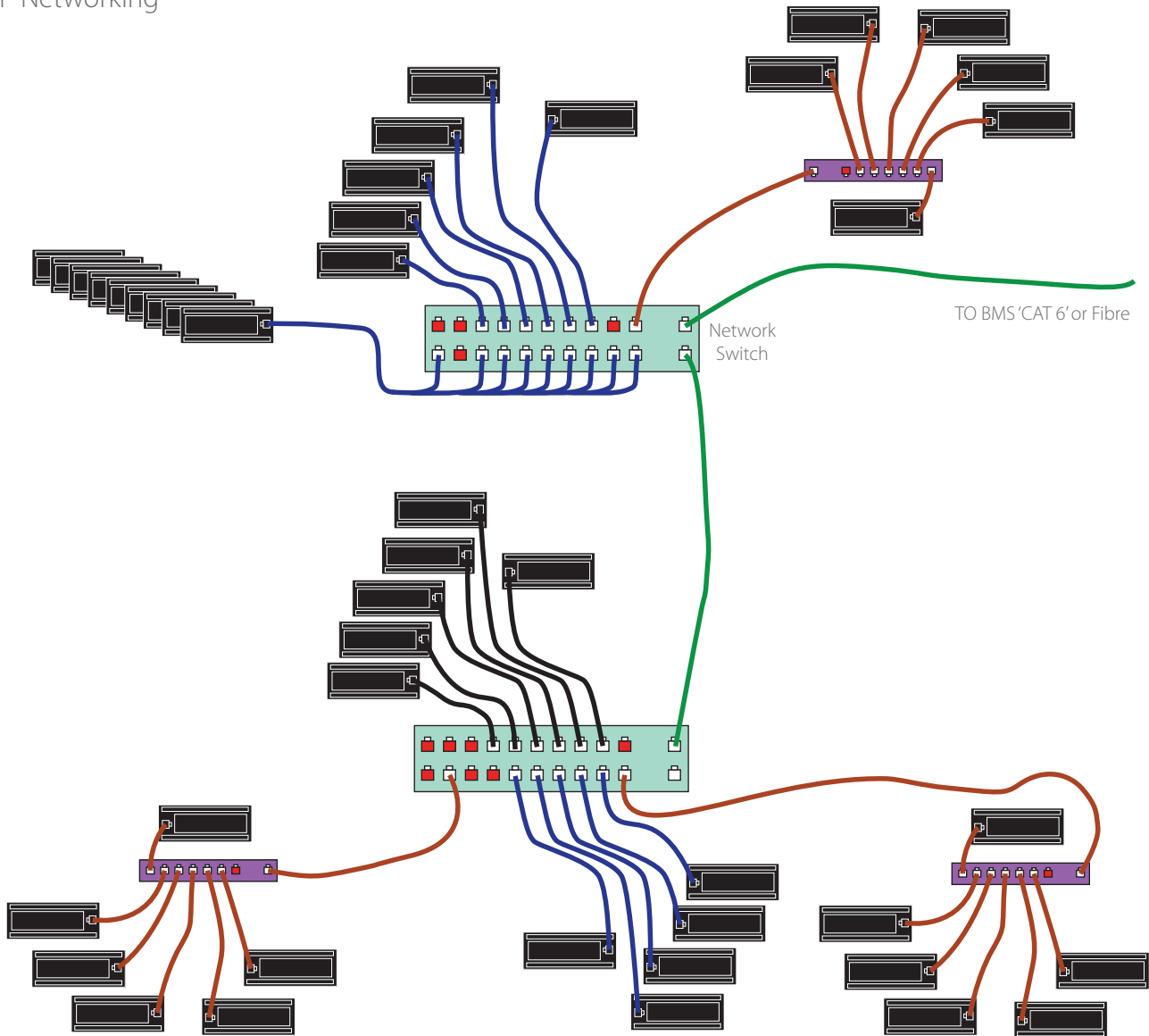
1. Start / Stop
2. Cooling valve position
3. Heating valve position
4. Set point
5. Return air
6. Supply air
7. Room air
8. An alarm

$$200 / 8 \text{ Points} = 25 \text{ DAC1146 Per Router}$$

If routers from another source have been purchased, then you should pay careful attention to the instructions that accompanied them in terms of connection and maximum loading.

Network Installation - BACnet over IP

IP Networking



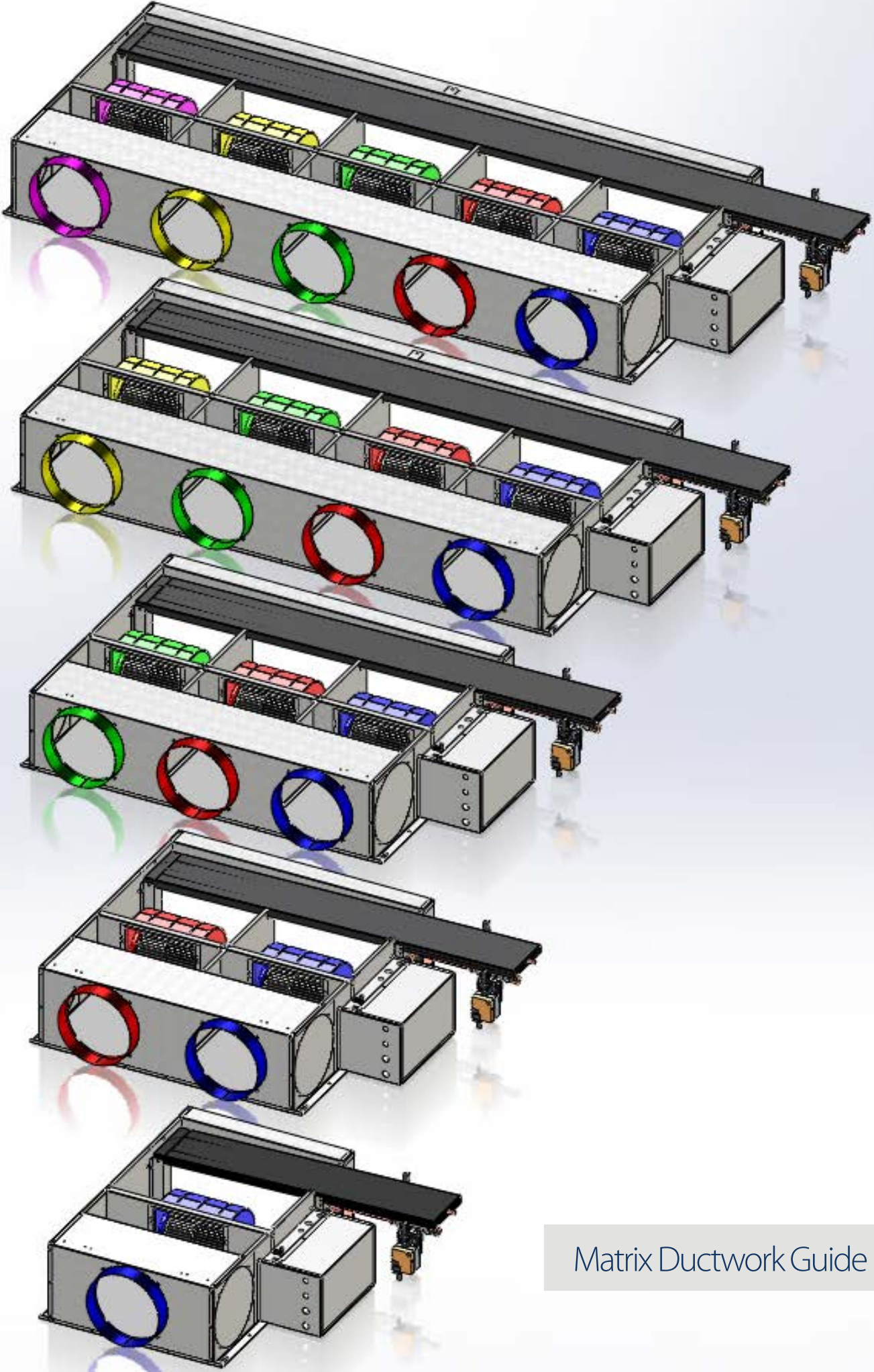
IP Sub Branch reduces Networking

BACnet over IP and BACnet over Ethernet are essentially the same networking style except with IP the potential for large numbers of units is not so limited.

Again a maximum of 250 units can be grouped into each subnet but with BACnet over IP you can have four subnets, the connection together of which is again, very straightforward.

If you have a project with over 1000 Matrix units, the network will require additional hardware. Should you need further advice contact Ability or your local Ability Agent.

With both the BACnet over IP and Ethernet, while in theory you could have 255 fan coils on each subnet, the reason this should be limited to 245 - 250 is to leave a few spare IP addresses for other devices that may be required in the future.



Matrix Ductwork Guide

There are a number of fan related differences between Matrix products and similar fan coil styled products. Installing without a clear idea of these differences can result in wasted time and damage.

Remember, a properly installed Matrix FCU needs no VCDs. If they have been inadvertently installed they should all be left in the fully open position.

These diagrams show a typical 3 fan / 3 spigot Matrix unit connected to swirl type diffusers.

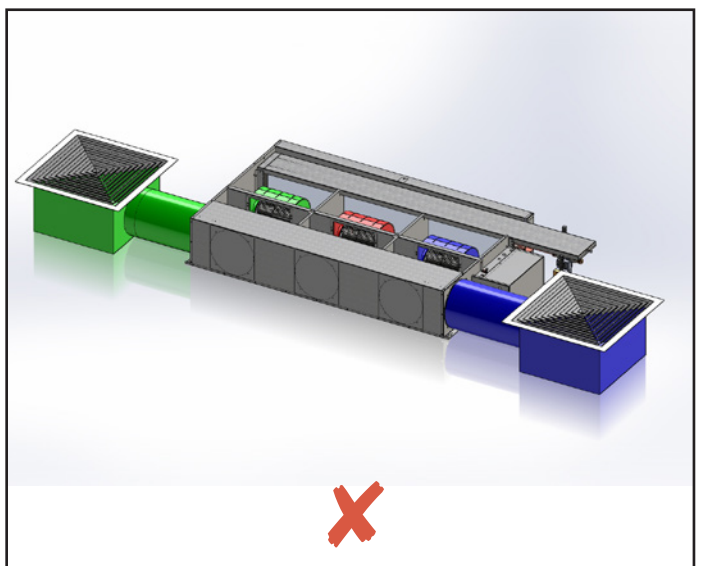
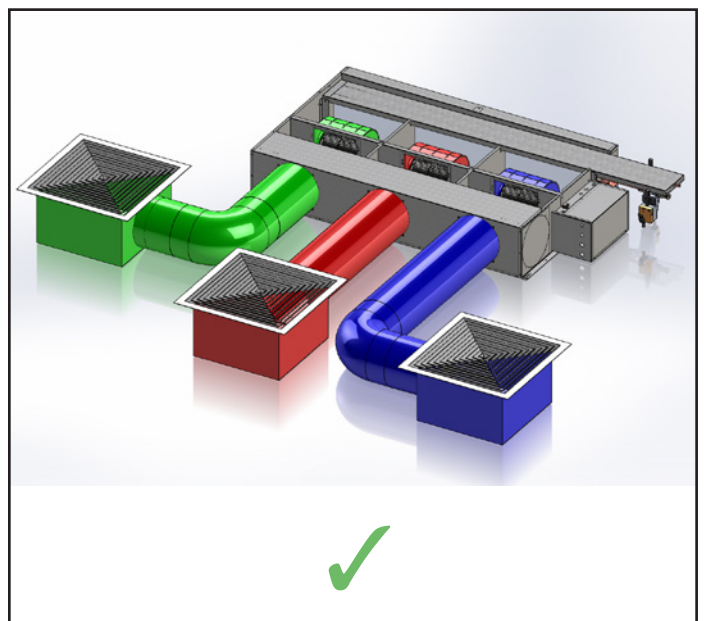
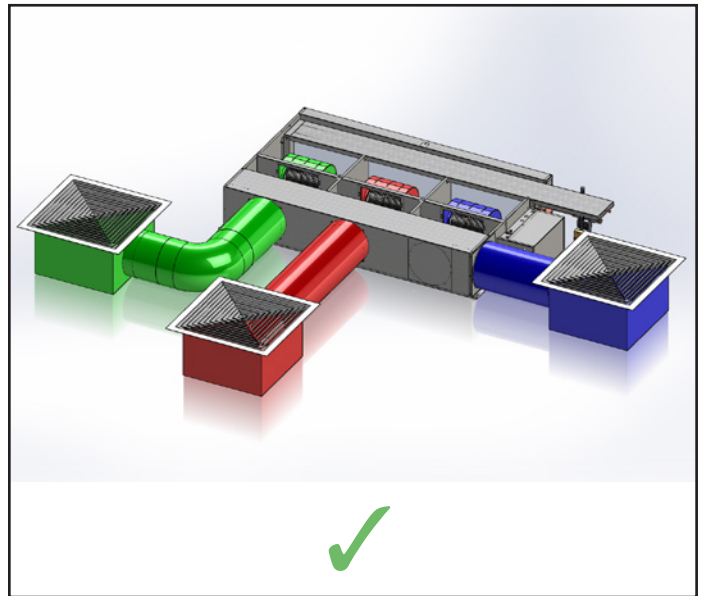
The basic rule with Matrix is each plenum discharge position should go to one duct and on to a single grille.

If you have a three fan Matrix it needs to be connected to three grilles, not two, not four. If you have a two fan Matrix it needs to be connected to two grilles, not one and not three!

There are exceptions but these need to be carefully considered and they do need to be the exception - not the rule. For example, two ducts can supply a single grille plenum but the air volume discharging from the one grille will be the sum of the air volumes from the two fans supplying it.

Your Matrix fan coils will be delivered with all the front spigots applied and with spigot blanking plates on the ends. The side spigot position is intended as an alternative to the closest front position and you should not connect both. The same applies for both ends of the unit.

This last illustration shows the centre 'red' fan 'stranded' with nowhere for the air it is generating to go. This fan if left activated will fail.



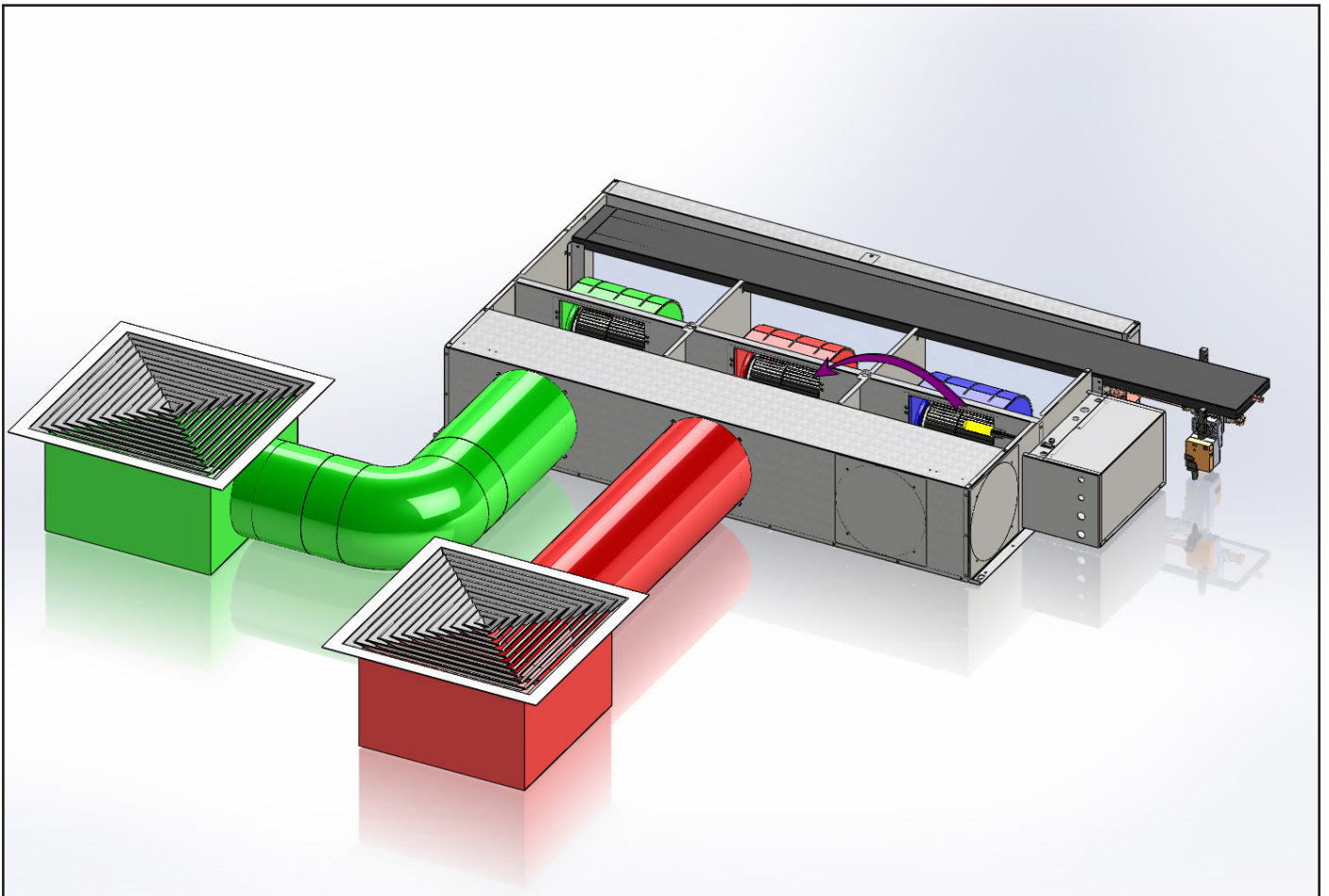
Deactivating a Fan

You **MUST NOT** block off an active fan without taking these necessary steps. If you block an active fan you will lose the air volume that fan was designed to provide and more importantly, that fan and motor will suffer and will fail in a very short period of time.

If you are left no choice (because of a physical constraint or similar) and have to block a duct with a fan attached, that fan and motor must be disconnected from the electrical supply; it must not be left running.

If the air volume is going to be unacceptably reduced by the loss of the deactivated fan, you will have to compensate by increasing the volumes of the remaining active fans through the software. This may influence the acoustics in the space as the specified duct air velocities may now be being exceeded.

The supply air sensor supplied on every Matrix unit is generally located in the discharge plenum chamber closest to the electric enclosure. If this supply air sensor is in the fan chamber you need to deactivate, the sensor must be relocated into another, active fan chamber.



Never run EC/DC fans of any type if the shrink wrapping is still over the filtered inlet section. This will also lead to fan failures in a very short period of time.

Connecting Fresh Air

Installing Fresh Air Connections & Return Air Sensor

If a fresh air supply is to be terminated at the intake of the Matrix unit then the duct should ideally be central about the intake.

It should also be an adequate distance from the filter to allow the mixing of the fresh air with the return air stream before it enters the unit; 500mm is ideal.

NB: If the duct is too close there is a danger that the fresh air will be 'grabbed' by a single fan in the unit and not be delivered evenly across the discharge grilles.

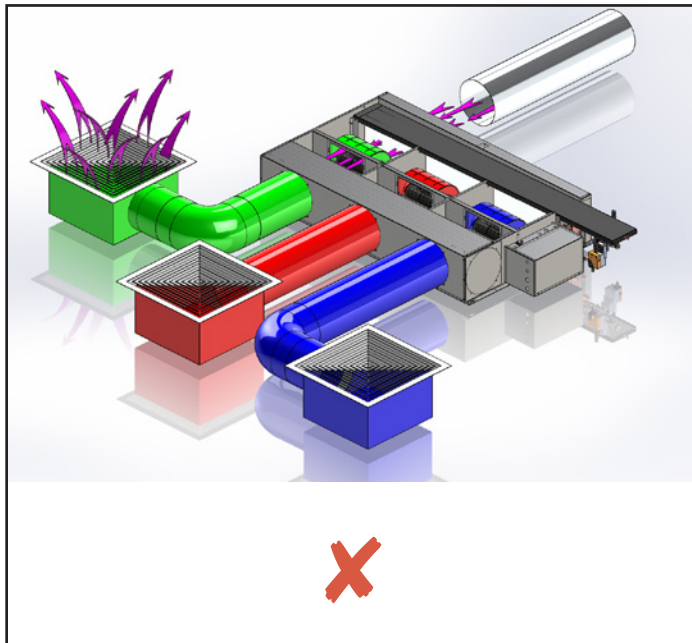
Room Sensor Location

If the installation has room sensors do not mount the sensors in direct sunlight, in a draft or near a door.

Room sensors can be affected by cold drafts in a plasterboard cavity, especially if they have been recessed into the cavity. Cold air from within the cavity can get into the sensor housing through the wire entry point and again, upset the readings.

Multi Room

If, after a fitout, a single Matrix unit now serves two or more rooms, the sensor position may need to be carefully reconsidered or potentially, the whole control strategy might need to be reconfigured. Ability has Multi-Room Matrix Strategies available - please ask for details.



Fault / Status Codes

A number of "Status Codes" are also available indicating the current status of a Matrix or one of its components.

These codes also indicate when a function is unavailable due to the components fitted. These status codes are as follows:

A value of -1 (EG: Valve position = -1%) indicates that a component such as a valve or fan is being held closed or off due to the currently active operating mode.

A value of -2 (EG: Power consumption = -2 Watts) indicates that the sensing component that this output relies upon has not been fitted and so the output is unavailable.

A valve position or a fan speed that is greater than 100% indicates that boost mode is active and that the air or water flow rates are temporarily exceeding design.

A valve position of 199% indicates that flushing mode is currently engaged.

Relocating Return Air Sensor

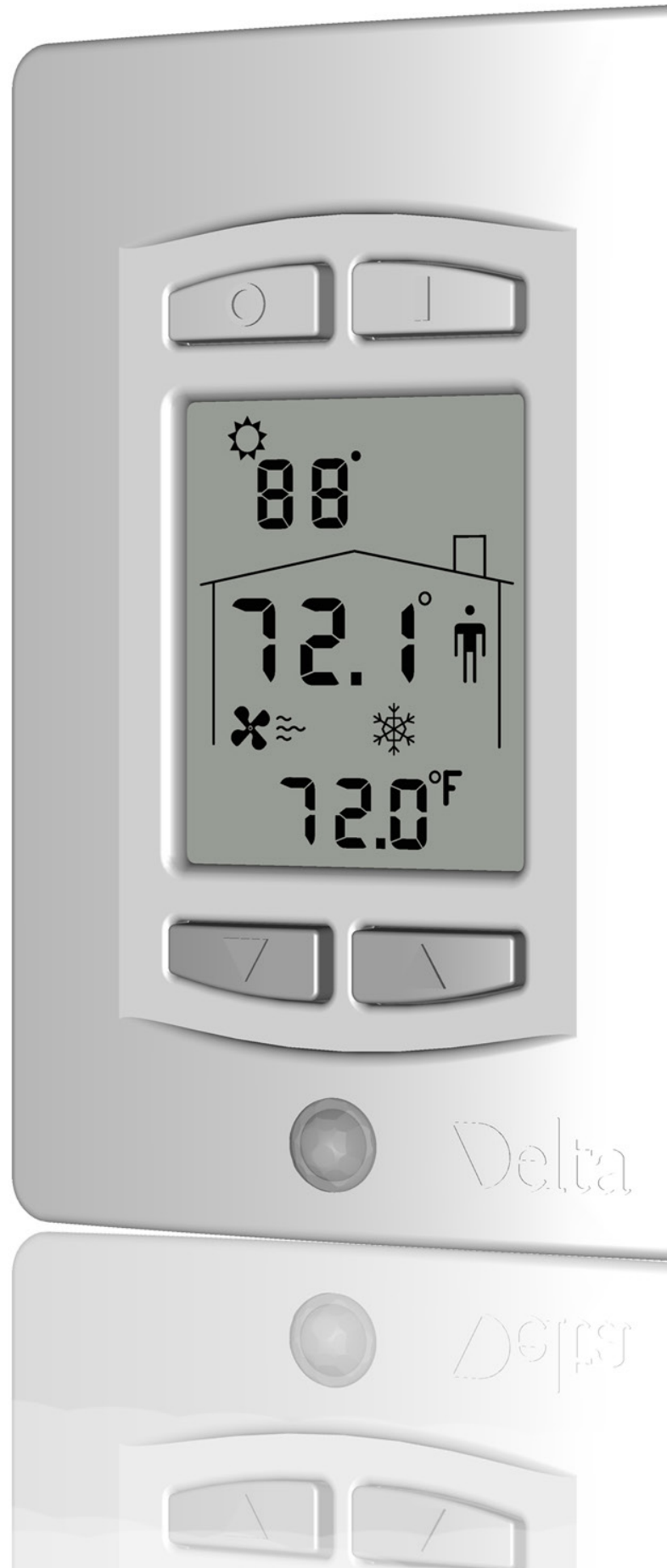
The return air sensor in the rear of your Matrix units needs to always see a temperature representative of the space temperature the unit is trying to control.

To achieve this may require an alternative sensor location be chosen if there is no position at the rear of the unit which is truly unaffected by either the fresh air or some other temperature influence.

The standard sensor included generally has 2M cable attached and this can be unravelled to allow the sensor to be relocated somewhere more representative. The downside of this simple approach is that the temperature difference logging across the coil (which will be lost if the sensor is moved) is used as both a useful diagnostic tool and as part of the 'Environmental Commissioning' process.

Environmental Commissioning is a routine in which the water quantity and balance are evaluated through 'airside' temperature difference rather than actual water flow measurement; this can be particularly useful with very small heating flow rates which often prove impossible to quantify conventionally. Environmental Commissioning is more fully explained in the commissioning guide.

The preferred solution is to install a second room / return air sensor over a spare input on the controller specifically set up for this purpose. This allows the unit to control the space based on the new sensor but retain the diagnostic features of the existing sensor. Any room sensor can be used providing it is a 10K3A1 thermistor type.





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