TITAN Products Ltd.

BACnet Variable Air Volume (VAV) Temperature & CO2 Controller

BACnet Enabled

Introduction

The TITAN CCM-VAV controller is an applications specific controller which can be used as standalone or part of an integrated BMS using the native BACnet MS/TP communications.

The controller incorporates all the inputs, outputs, features and functions required to provide flexible and accurate environmental control on demand of a Variable Air Volume system based on temperature and CO2 conditions within the measured space.

FEATURES

- BACnet MS/TP Communications
- Flexible temperature & fan control options.
- 0-10V or 2-10V CO2 damper control
- 4 x Temperature Inputs for averaging options, room sensors, external sensors and Set Point adjustment
- Options for Re-Heat control
- Damper Feedback to determine control parameters
- Reverse Damper control for Summer / Winter changeover
- Fault Indication for high temperature cut out & no air flow indication
- Summer Compensation
- Fully compatible with Attractive RDU-4 display
- Fully compatible with Titan Products environmental sensors

SPECIFICATION

Power Supply:	24 Volt AC (+/- 15%)
Power Consumption:	3 VA (no RDU) plus outputs 8 VA with RDU display
Outputs:	4 x 0-10V (5mA max) control 2 x 24VAC Triac (350mA max) 2 x Voltfree relays (240V 5amp max)
Inputs:	4 x 10K3A1 Thermistors/s 7 x 0-10V or DI
Display Options:	Built in top display or RDU-4 room display user interface.
Communications:	Native BACnet MS/TP
Network:	MS/TP RS485
Settings & Options:	Set via in-built display or RDU or FPT
Enclosure:	DIN Mounting (IP20)
Dimensions	124 mm wide 93 mm high 48 mm deep
Order Code:	CCM-204/VAV

VAV TEMPERATURE CONTROLLER V01

DESCRIPTION

The TITAN Variable Air Volume controller is designed to control the volume of air delivered to the space dependant on the temperature demand (heating or cooling) and CO2 levels. The VAV controller accurately positions the air damper through full PI modulation whilst having minimum and maximum damper position setting to match the zone requirements.

For terminal units with re-heat requirements the controller offers 0-10V or 24VAC TPC, PWM or up to 2 stage On/Off control. For Fan assisted terminal units the controller can be configured to allocate a digital output (DO) for fan enable as well as an input for fan proving.

Control Options

All the control strategies and settings can be viewed and selected via a hand held field programming tool, a room user display unit (RDU) or through the on-board controller display if fitted.
The control strategy options are: -

- Single stage heating or cooling.
- Single stage heating/cooling with Db.
- Two stage heating with single stage cooling.
- Fan Speed Control of EC fan.
- C02 Priority or Independent CO2 Control (Damper or Fan or Both).
- Analogue damper control offering 0-10V or 2-10V on each output.

All control strategies can use the option for summer compensation of the cooling setpoint.

Summer / Winter Changeover

When a single output is used for Summer (cooling) and Winter heating. Dictated by a seasonal change from the BMS then the damper control output will operate in reverse.

Within the control strategies there is a setup option to use relay outputs to start/stop associated plant or provide 2 stage electrical reheat under the temperature control.

User Display & Settings

The configuration and setup of the VAV controller can be done via a RDU or the FPT or the controller built in display (if fitted).

The operational Modes can be: *Off/On /Frost Protection/High Limit Protection/ECO.*

All temperature values and setting are accessible via the RDU or FPT or Built in display

When using an RDU there is an option to limit the control setpoint range full range of 0-50’C.

Supply air Low Limit and High Limit Temperature Setpoints are also available and these will require a supply air temperature sensor

Control Outputs

The 0-10v modulated control outputs can be allocated to any of the analogue outputs AO1 to AO4. Each controlled output can be set to provide PI control with slew rate and these are config/setup dependant on the control strategy required. In addition to the 4 x analogue outputs there are 2 x 24Vac Triac outputs which can be used for TPC floating control of Heat or Cool or PWM for heat.

In addition the 2 x Triac can also cater for:

- 2-stage Re-heat (24VAC On/Off control). Or for

- Fan Enable
- Heat enable

All analogue control outputs have a min and max control range settings.

Note: The 2 x Relay outputs, if not required for other functions, also have options for: Starting associated plant such as Fan, Heat enable, or On/Off control (single or 2 stage)

Inputs

The 4 x Temperature Sensor Inputs have setup options for control with averaging, low/high limit control functions or external temperature. These inputs can be configured for a remote Temperature Setpoint Adjustment function using a 1k to 11K potentiometer.

The 7 x 0-10V or volt free Digital Inputs will offer the specific allocation to functions required under the VAV control.

The inputs options available include:

1 x AI for C02 control sensor with option for individual control or priority over temperature control used for damper and / or fan control.
1 x AI (0-10V) for VAV Damper position or volume feedback signal with the units expressed 0 to 100%
1 x AI (0-10V) for RSA. Optional and the RSA will provide +/- values from the default controller SP.
1 x DI used for controller On/Off for occupied / unoccupied periods.
1 x DI used for HTCO. Monitoring & Alarm, shuts down heat output if activated, display fault on RDU.
1 x DI for air flow switch and if de-activated will shut down the controlled outputs.
1 x DI for window contact to disable the controller and place in unoccupied mode (off).
2 x DI for Fire shut down (1 action shuts down all control and closes damper output to 0V. The other opens damper fully to 10V with an option to run the fan at a fixed speed).
1 x DI (momentary push button) for Air purge. If activated the damper will open to its Max V setting and the fan (if controlled) will also run at its Max V for a pre-set time 0-15mins to purge the room.

Fault Indication

If any of the Control temperature sensors (S1 to S4) go faulty, the controller will indicate the fault in the display if used. The controller display can indicate the status of any of the DI inputs that are used for controller interlocks such as HTCO (High Temperature Cut Out) Fail, No Air Flow, etc. All control status conditions and alarms/faults can be viewed over the BACnet BMS.

Control Strategies

Single Stage Heating or Cooling

This selection provides temperature control via designated AO's for heating or cooling. The controller has optional settings for minimum and maximum AO output values during the control cycle.

Diagram shows heat only

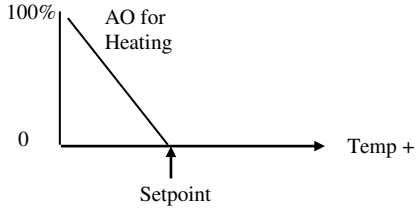
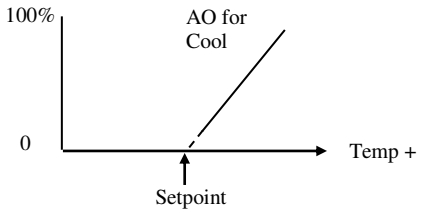


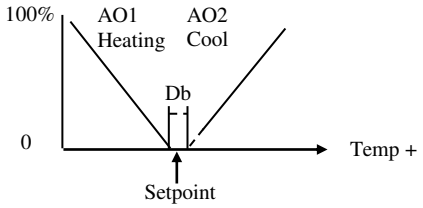
Diagram shows cool only



1 Stage Heating and 1 stage Cooling

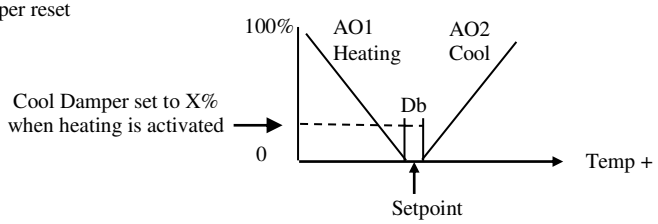
This selection provides temperature control for heating and cooling with a Dead Band between the heat and cool cycles. The controller has optional settings for minimum and maximum AO output values.

Diagram shows heat/cool



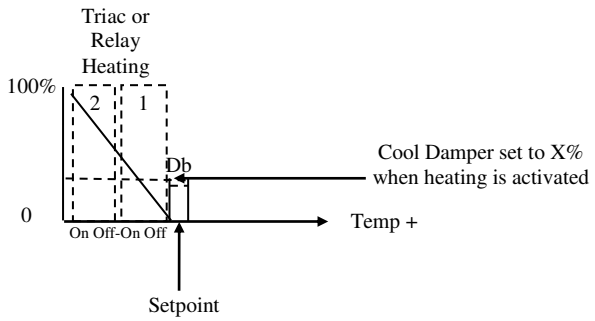
When the application calls for heat & cool and the VAV damper is used on the cooling cycle there is an option to reset the cooling output to a fixed percentage intermediate position during the heating cycle.

Diagram Shows Heat Cycle
with Damper reset



The heating control can be a 0-10v for a valve or a Thyristor driven by 0-10v, PWM or On/Off from a relay or Triac 3 point floating control. If single or 2 stage re-heat is required then the relays or Triac outputs can be configured to operate the heater (single or two stage).

Diagram Shows Heat Cycle
with 2 stage heat &
Damper reset



Setting the Control Parameters

The following setting are accessible via the RDU/FPT, Built in optional display or over BACnet:

Controller Temperature Setpoint
Minimum Temp Setpoint Value (RDU)
Maximum Temp Setpoint Value (RDU)
RSA +/- range (if used)
Integral Time
Proportional Band (Pb) for Heat
Proportional Band (Pb) for Cool
Heat/Cool Dead Band Db.
Slew Rate
Fan Control heat Proportional Band (Pb)
Fan Control cool Proportional Band (Pb)
Fan Offset +/- 5°C
Fan Min/Max output in heat
Fan Min/Max output in cool
C02 SP level (range 0-1500ppm)
C02 Pb (range 0 – 500ppm)
C02 Slew Rate (range 0 to 3mins)
C02 max V output
C02 Control options:
- ***Independent when no temperature control on the damper ouput***
- ***Priority over temperature control.***

Damper Control

In a VAV system the VAV Damper min & max air volumes are pre-determined by the needs of the space under control. The VAV damper actuator or VAV pressure sensor is used to provide a 0-10V feedback signal to the controller. This signal represents the 0 to 100% damper movement with a linear relationship. However the 0-10V VAV feedback signal and the controller 0-10V AO control signal are not directly proportional therefore the feedback signal values are used to define the controller AO range (min/maxV) under normal control conditions. The following settings are used for the setup:

Minimum Air Volume V-Min % (0 range 0-100%)

The setting for Minimum Air Volume and the corresponding AO value for V-Min air volume is set by the VAV damper position 0-10V feedback measured on the allocated controller AI.
The AO minV value that represents the V-Min will be set when the feedback value equals 0V. This setting determines the minimum output value of the AO under normal control conditions. When the controller is switched OFF the output goes to 0V.

Maximum Air Volume V-Max % (0 range 0-100%)

The setting for Maximum Air Volume and the corresponding AO value for V-Max air volume is set by the VAV damper position 0-10V feedback measured on the allocated controller AI.
The AO value that represents the V-Max will be set when the feedback value equals 10V. This setting determines the maximum output value of the AO under normal control conditions. When the controller is switched OFF the output goes to 0V.

Intermediate Position V-Norm% (0 range 0-100%)

The setting for intermediate position V-Norm is used to position the VAV damper to a fixed position during the heat cycle. The feedback value for V-Norm is always set at a fixed intermediate value in between the min/max values. This represents the air volume required for the space during the reheat cycle..
The AO value that represents the V-Norm intermediate position will be set when the feedback value equals the V-Norm value of 0 to 10V. This setting determines the fixed output value of the damper control AO during the heat cycle. Whenever the controller commences a heat cycle determined by the room temperature the damper

AO drives the damper until the feedback signal reaches the V-setting. The damper then remains at this value for the duration of the heat cycle. When the controller is switched OFF the output goes to 0V.

Entering the Damper Control Range Manually.

The Controller AO range for the damper output needs to be entered into the controller to calibrate the control valve with the feedback value.
This calibration can be done manually by an engineer via a FPT, the inbuilt display (if fitted) or over BACnet as long as the voltage values are available:
V-Min x % value = AO V min output
V-Max x % value = AO V max output
V-Norm Intermediate value 0-100% = AO V mid position under the heat cycle.

There is an optional strategy to perform this calibration which can be done automatically during commissioning after all the component parts are connected and the main air system is running. The auto calibration is described in the following statement:

Auto Damper Position Calibration:

At commissioning/site setup the VAV controller software incorporates a Damper Calibration routine.
* When you enter this routine via the setup menus on the RDU or the FPT the controller AO's are driven to 0Volt for synchronisation.
* First of all the voltage feedback values of V-Min, V-Norm, and V-Max must be entered into the controller for the calibration reference. If the values are not entered then calibration cannot proceed. The increments for the feedback values are 0.1V. (0.1%)
* When the Damper Calibration is initiated the damper AO is slowly driven to 10V thereby opening the VAV damper.
* During this period the 0-10V Damper or pressure sensor feedback signal is monitored until it reaches a value of XV-Max. This XV-Max value will have been manually entered into the controller by the engineer with FPT or over BACnet. When the feedback reaches this point the Controller AO value is recorded and stored and this becomes the V-Max % position for control purposes.
* Once V-Max is recorded the controller AO is now driven closed until the feedback value reaches the intermediate V-Norm setting and at this point the Controller AO value is recorded and stored and this becomes the V-Nom % position used for a fixed position in the heat cycle.
* Once V-Nom is recorded the controller AO is now driven towards 0V until the feedback value reaches the V-Min value which has been set in the controller at which point the Controller AO value is recorded and stored and this becomes the V-Min X% position for the control range.

Notes:

- The time this routine takes will depend on the run time of the Damper Actuator.
- The Damper position is measured on the feedback voltage and is in percentage values of the 0-10V range.
- The Controller AO for heat and cool control is measured in the actual value of the analogue output voltage.
- Manual entry is required for the V-Min & V-Max of the damper feedback before the calibration can run. When Calibration is run all the recorded values are stored automatically in the controller non-volatile memory which can only be erased by implementing the setup routine again.
- The damper actuator run time can vary dependant on the size of the VAV unit and this run time can be from 15 seconds to 300 seconds dependant on the manufacturer. When short damper run times are used there is a need to prevent overrun during in calibration. To cater for this there is a delay slew rate setting on the AO for Auto Calibration variable from 0 to 300 seconds.

During normal operation the Damper feedback 0-10V signal is monitored continuously with a range of 0-100% and this can be viewed on the RDU or over BACnet.

Statement of the control action:

COOL TO HEAT
With a decrease in measured temperature from the setpoint the damper cooling output will modulate down to the minV or its V-Min calibration value, whichever is used.
The damper stays is this position through the Db until it reaches the start of the heat cycle at which point the cooling output takes up the intermediate V-Norm position first, then the heat AO is released. Some damper motors will have run times up to 300 seconds so there are 2 options to ensure the damper is in position before the re-heat is allowed on:
a) Set a heat delay on timer adjustable 0 to 300 seconds which starts whenever heat is called for and allows time for the damper to take up its position.
b) Wait for the feedback signal.

Both options can be set in the VAV controller with the delay timer being used to prevent heat short cycling around the start of the heat cycle. The heat start delay timer (if set) will always take priority over the cooling damper feedback signal.
The heat delay on timer (if set) will be activated every time the controller enters a heat cycle.

HEAT to COOL
If in re-heat and the measured temperature calls for cooling then the heat AO modulates down to 0V the damper cooling AO moves from its intermediate mid position to the V-min value and stays in this position through the Db and at the start point of cooling the respective AO is released for modulation.

Low Limit Temperature Sensor (option selection)
An optional Low Limit temperature sensor can be fitted in the discharge air duct to prevent cold air entering the occupied space and this will reset (reduce) the cooling or increase the heating by overriding the room setpoint.

Low Limit Setpoint (range 0-50°C)
Low Limit PB (1-5°C)

High Limit Temperature Sensor (option selection)
An optional selection using the same low limit discharge temperature sensor to reduce the temperature input if the supply air exceed the set value

High Limit Setpoint (range 20 to 80°C)
Low Limit PB (1-5°C)

Remote Setpoint Adjuster (RSA)
A room temperature setpoint adjuster can be configured using a resistive potentiometer (1K to 11K) into one of the sensor inputs S1 to S4 or a 0-10V setting unit connected to any of the AI's

Remote Reset Value (range up to +/- 10°C)
If a remote reset (RSA) is configured then the SP reset value is restricted to the maximum reset value. The value set is + or - from the controller default setpoint. The reset value when the RSA is at midposition is zero.

Night/Unoccupied Setting (Off, ECO or Frost or High Temp)

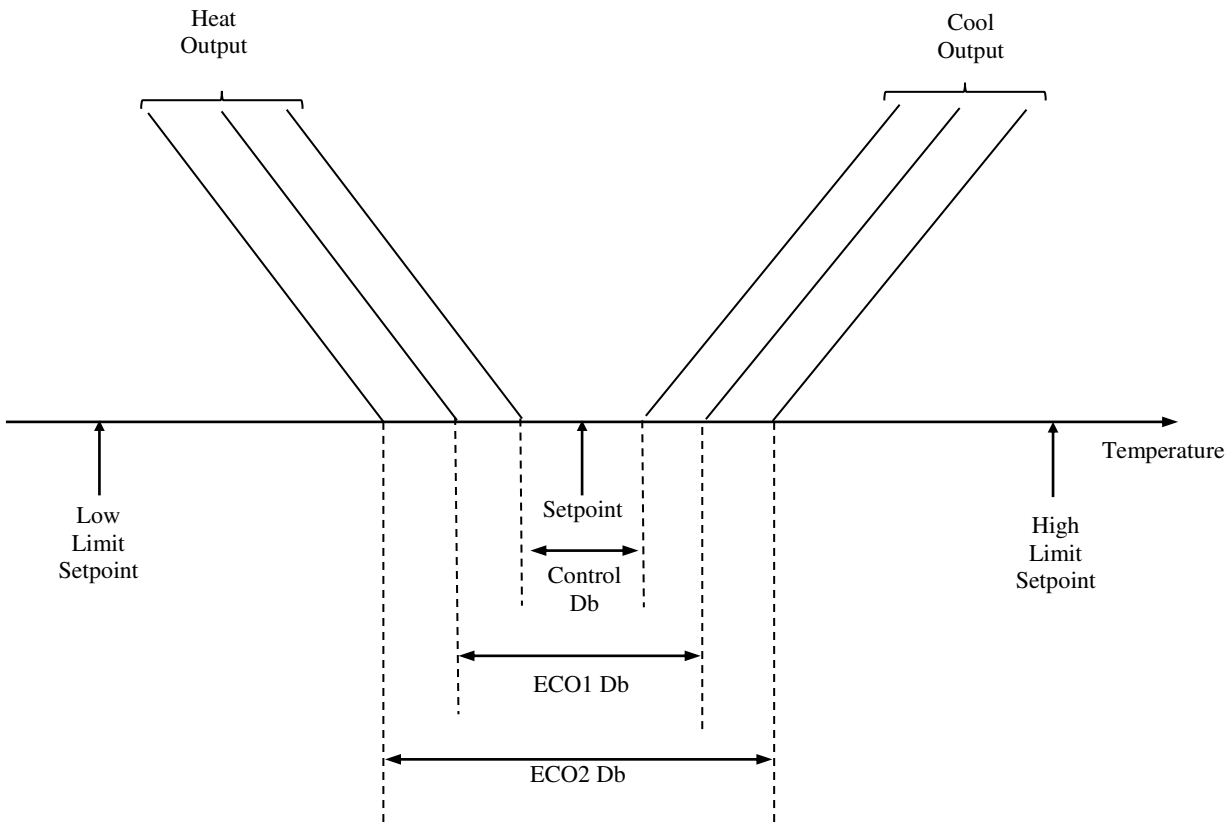
This is to select the controller status when the controller is switched into the Off condition. Options are: -
Off = No Frost Protection or ECO operation is provided
ECO1 = A new operating SP which is determined by the ECO value.
ECO2= A new operating SP which is determined by the ECO value.
Frost = In the Off condition Low limit Frost protection is provided.
High = Protection to increase the cooling when high temp is experienced.

Night/Unoccupied Operation

The mode of operation can be determined by the RDU On/Off button, the DI allocation and the BMS.

- When RDU switches Off this will put the controller into Off or ECO1, whichever is configured. ECO1 is classified "Approaching Comfort Level". A second ECO setting, ECO2, can be also configured and is classified

as ‘Low Comfort Level’ during unoccupied periods. The BMS can also control the unoccupied settings via BACnet placing the controller in the relevant unoccupied condition when required.



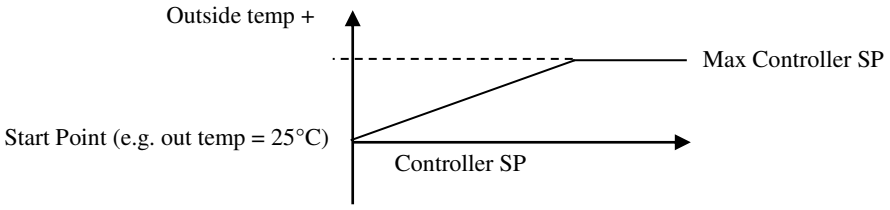
Summer Compensation (option selection)

When selected, Summer Compenstaion rasies the controller setpoint as the outside temperature increases above the external temperature start value. The reason for this is to economise on cooling when the external temperature is high. This also prevents what is know as “thermal shock” on occupants which occurs when a person walks into an air-conditioned space from a high external temperature condition. The summer compensation only acts on the cooling cycle start point with the heat start point remaining fixed at the default controller Set Poiny.

For Summer Compensation to operate the control strategy needs an external temperature reference. This is normally delivered via a gobal tranmission performed by the BMS

The following settings are available for Summer Compenstation:

A start point °C of external temp which will be above the normal controller setpoint. (Range 15 to 50°C)
A ratio for the increase of SP for each °C rise in external temp above the start value (range 0.5 to 2°C)
A controller Max limit on the Setpoint at which summer compensation is inhibited. (range 20 to 50°C)



If an external temperature reference is used by the VAV controll there is an option to show the external temperature on the RDU (if used).

Master/Slave Operation

The Master/Slave Group control will function on a stand-a-lone private network or on the BMS BACnet MS/TP network.

Multiple controllers can function as part of a group, consisting of one Group Master and one or more Group Slaves. The desired Group Control can be selected in the Engineers Settings or via BACnet.

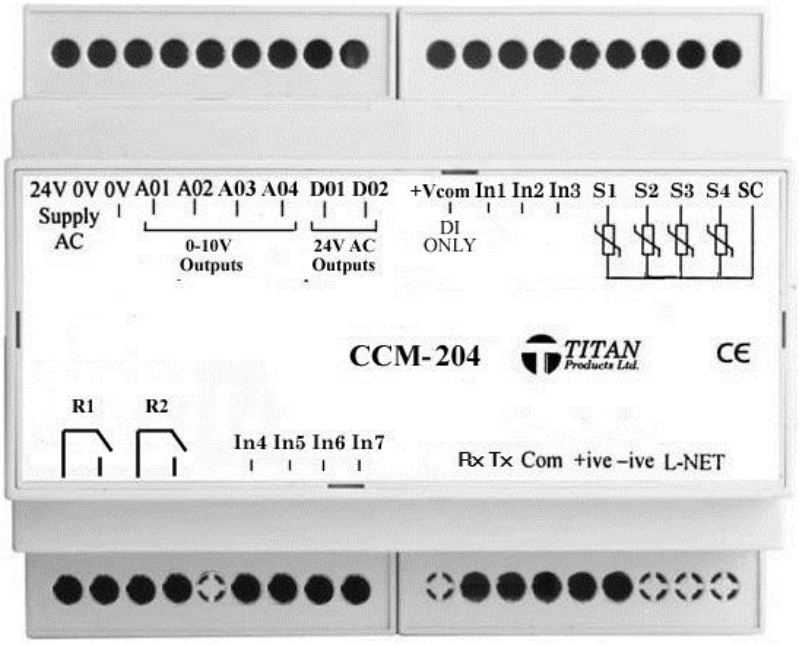
When Master/Slave is used in the CCM-VAV controller the control room temperature sensor, the on off input and occupancy detector must be connected to the configured inputs of the Master controller.

If Summer Compensation setpoint is used then any external temperature sensor must be connected to the Master, if the external temperature reference is from the BMS then designated sensor input in the Master must be taken out of service and the BMS external transmission should be done to the Master in each group.

IMPORTANT:-

Except for "Out of Service" flags the Master and Slave controllers must be **set up and configured** identically to ensure that the Slave is a true mirror of the Master in all aspects of control and functionality. The only setup that is unique to each product in a Master Slave Group is the MAC address and the Device ID.

CONNECTIONS



TITAN
Products Ltd.

Tel: +44 (0161) 406 6480
Fax: +44 (0161) 494 8309
Email: admin@titanproducts.com
Website: www.titanproducts.com