CYLON smart energy control

UNITRON UC32. How-To guide

How to add Energy Optimisation to a UC32 Field Controller Strategy

A UC32 Field Controller can be configured to monitor environmental parameters over a period of time and learn from them the optimum times for switching plant in order to minimise energy usage.

The elements of the Strategy that work together to achieve this are collectively referred to as an “Optimiser”. An Optimiser can be set up to govern Heating, Cooling, or a combination of both.

This document describes the component modules and connections required within a Strategy that is to act as an Optimiser.

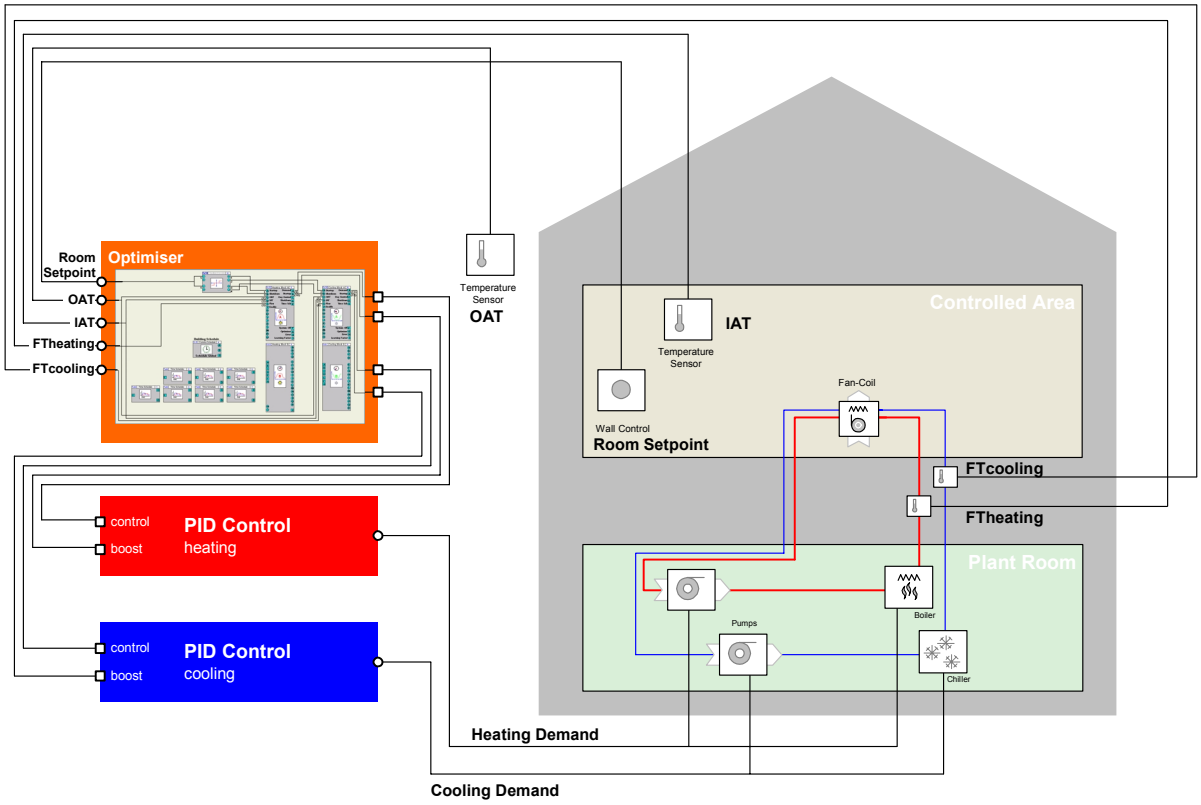
In order to set up the Optimiser as described in this document, you will need the following product versions:

UC32 Firmware version 6.1.7 or later

UEC Software version ETv6.60 build 6 or later

What is an Optimiser?

An Optimiser is an element within a Field Controller Strategy that acts to minimise energy consumption by observing environmental conditions over a period of time and learning from those observations the optimum times for switching plant in order to achieve the required conditions during occupancy.

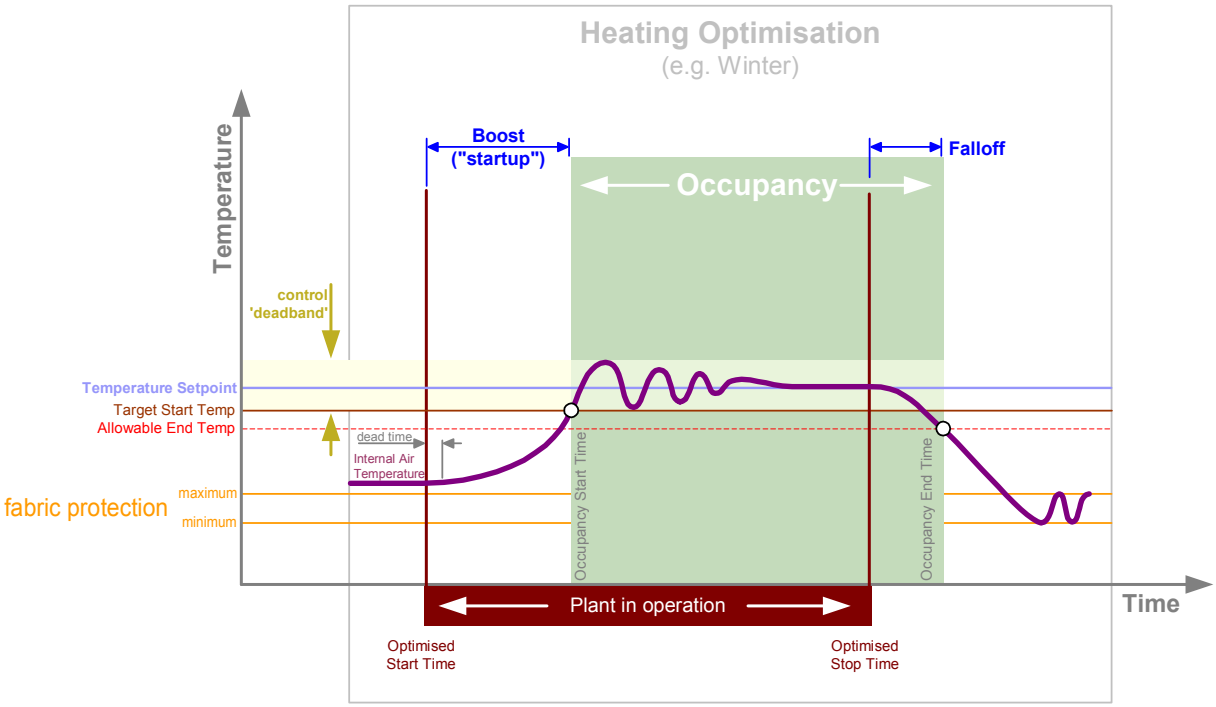


How does an Optimiser operate?

Heating Optimisation

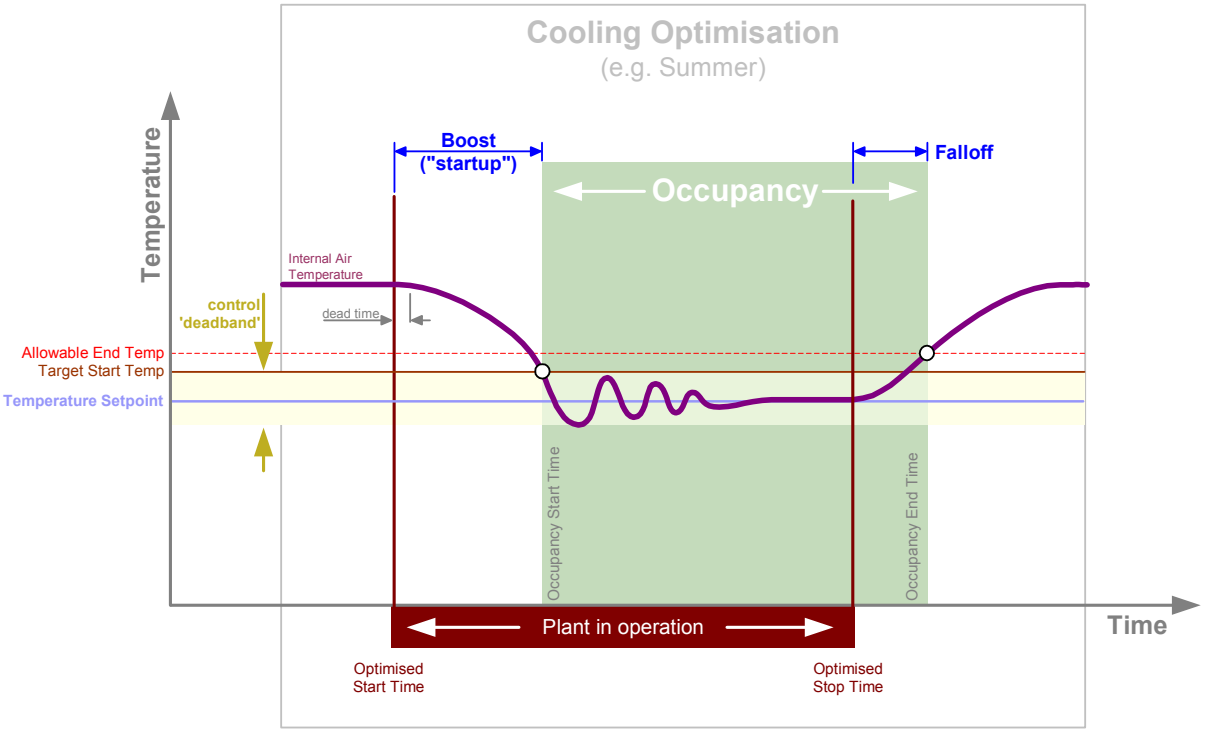
For example, to Optimise heating, the heating system should start operation before occupancy starts at the latest time that would allow the required temperature to be reached just as occupancy begins.

Energy can also be saved by turning off the heating system before the end of occupancy, if this can be done without the temperature falling below acceptable levels until after the end of occupancy.



Cooling Optimisation

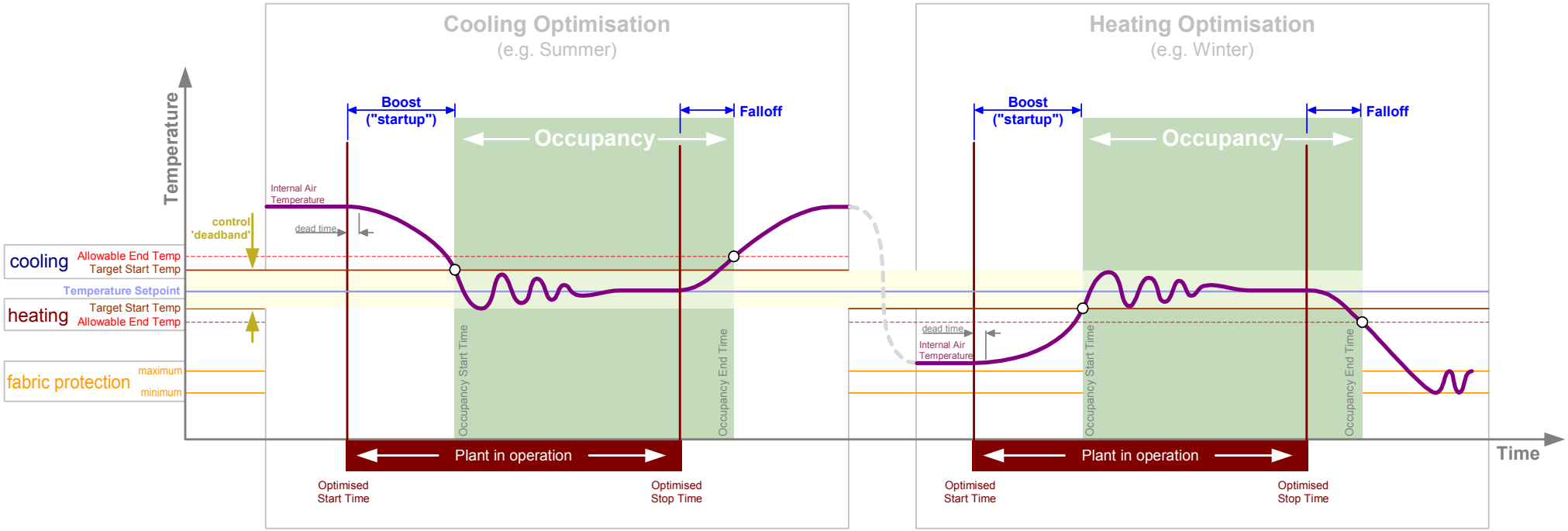
Similarly, when optimising the energy usage during cooling, the cooling system should start operating at the latest time before occupancy that will allow the required temperature to be reached just as occupancy begins and stop operating at the latest time that would not allow the temperature to rise to an unacceptable level before occupancy ends.



Combined Optimisation

It is advisable to implement both Heating Optimisation and Cooling Optimisation in the same strategy. Only one of the two will operate at any one time, but by having both set up you can ensure optimised energy use even if conditions vary widely outside of Occupancy times.

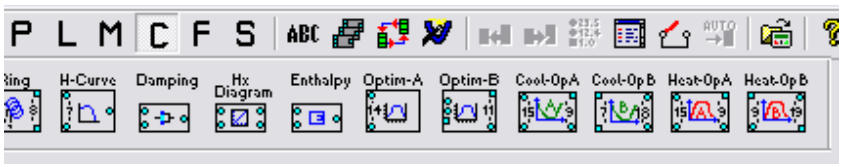
For example, temperatures outside of Occupancy could change significantly between summer and winter.



Setting up an Optimiser in a Field Controller Strategy

The magnitude of the Preconditioning and Falloff times – and hence the Optimised Start and End times - are determined by analysis of historical data, carried out by the partial strategy described below.

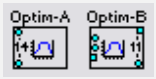
The Optimiser modules are available on the “Control” module bar:



Note: Legacy Optimiser modules are still available in the “Control” module bar.

New Optimiser Modules: 

(these modules are the ones used in this document)

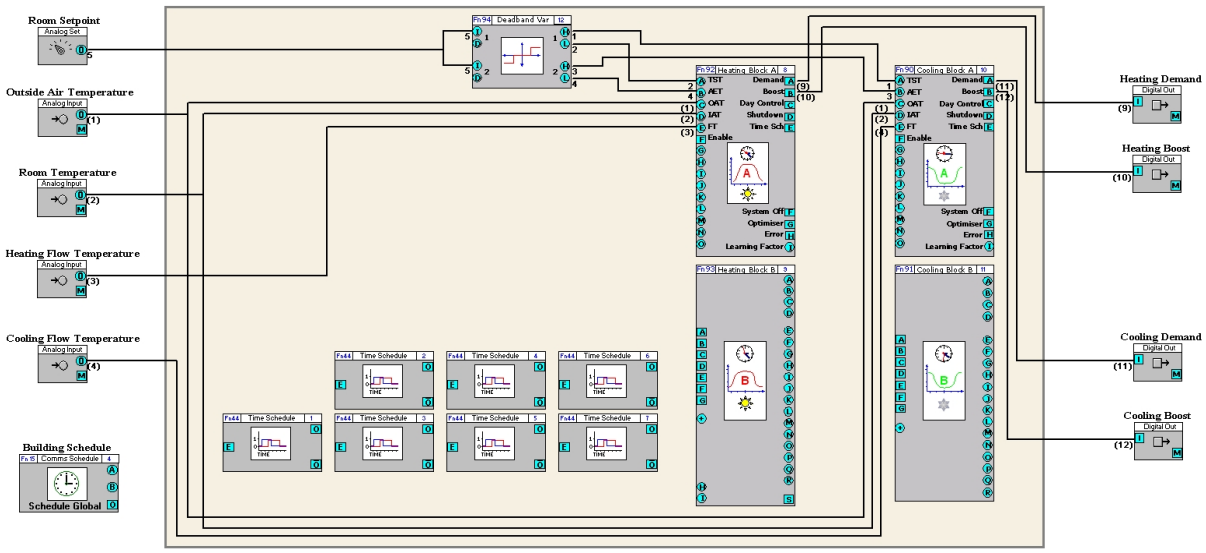
Legacy Optimiser Modules: 

(These are required for compatibility with existing Strategies only)

It is recommended that an Optimiser is set to monitor **both** heating and cooling. To set up such an optimiser, the following blocks must be in sequence, so they **must** be added to the Strategy in the order shown here:

1. Field Controller Time Schedule (Monday)
2. Field Controller Time Schedule (Tuesday)
3. Field Controller Time Schedule (Wednesday)
4. Field Controller Time Schedule (Thursday)
5. Field Controller Time Schedule (Friday)
6. Field Controller Time Schedule (Saturday)
7. Field Controller Time Schedule (Sunday)
8. Optimiser block A (Part 1 of 2) for Heating
9. Optimiser block B (Part 2 of 2) for Heating
10. Optimiser block A (Part 1 of 2) for Cooling
11. Optimiser block B (Part 2 of 2) for Cooling
12. Other Strategy modules as required.

Note: If only Heating Optimisation is required, 10 and 11 above should not be added to the Strategy. If only Cooling Optimisation is required, 8 and 9 above should not be added to the Strategy.



The inputs on Optimiser block A (in both Heating and Cooling) must be connected as shown above. The outputs can then be connected to the Demand and Boost points as shown.

Operation of the Optimiser

Linear Model

A Linear Model is used initially by the Optimiser to estimate the Boost start time, when no historical data is available.

The Startup period is calculated as follows:

Heating

```
Boost Period = A(TST - IAT) + B
```

Cooling

```
Boost Period = A(IAT - TST) + B
```

Where:

A and B are user-adjustable constants

TST is Target Startup Temperature

IAT is internal Air Temperature

Note: It is recommended that B be greater than 20 (minutes)

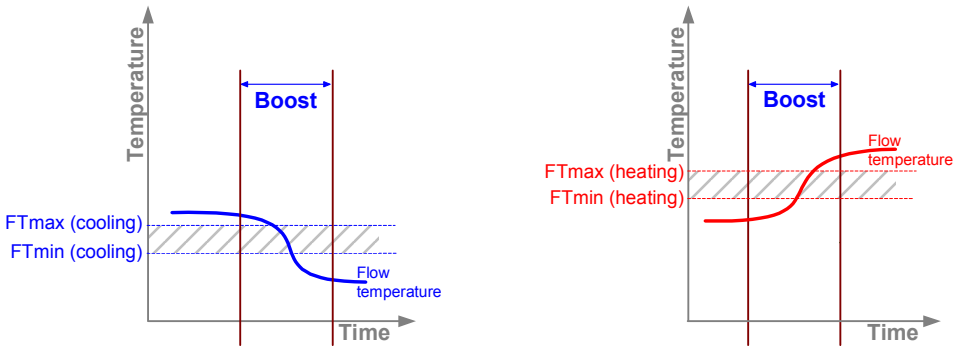
Learning Factor

Each time the Target Temperature is reached during the Boost period (Startup), “Learning” occurs, and the Learning Factor is incremented.

Once the Learning Factor reaches 6 or more, the Adaptive (Learned) model is used (to calculate the start time of the Boost period) instead of the Linear model.

There are a number of conditions that must be met before Learning can take place.

1. If Flow Temperature is being monitored, then in order to verify that plant is operating (Sanity Check) while the Optimiser is attempting to learn, the Flow Temperature must be outside the FTmin – FT max range as described below:



In Heating Optimisation, the flow temperature must be below the minimum temperature in the range, (i.e. below the value of FTmin) at the start, and must rise past the maximum temperature (FTmax) during the boost period.

In Cooling Optimisation, the flow temperature must be above the temperature range before Boost, (i.e. above the value of FTmax) at the start, and must fall below the minimum temperature (FTmin) during the boost period.

If the flow temperature does not meet these conditions before the start of Boost, the Learning process will not take place in the Optimiser.

2. Boost (Startup) period must be at least 20 minutes.

Fabric Protection

“Fabric Protection” is a behaviour that can be enabled in the Optimiser, which prevents damage to fabric and other contents in the building by keeping the temperature above a specified minimum at all times.

Note: Fabric Protection only applies to Heating Optimisation.

Inputs and outputs required for Optimiser

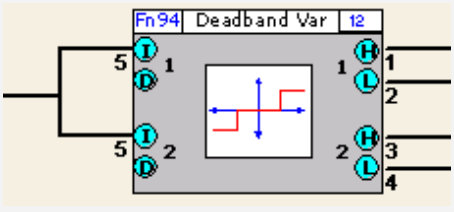
A connected group of Strategy modules configured to act as an Optimiser monitors the following parameters, which are either set as constants or provided by other elements within the overall strategy:

Inputs

The following points values must be provided by points in the Strategy outside of the Optimiser section:

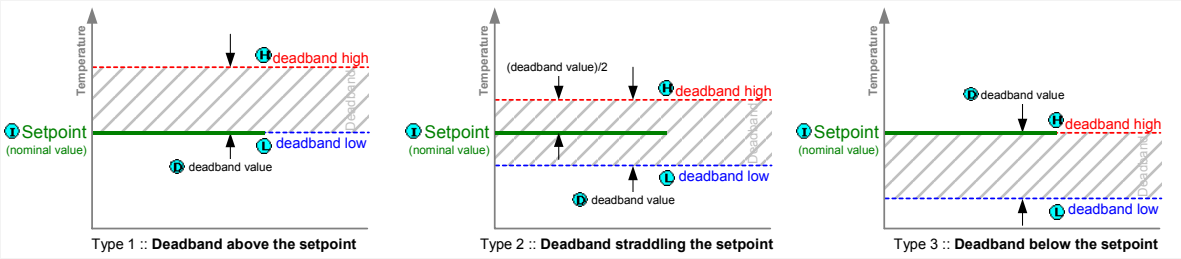
Parameter Name parameter description	Nature Connector diagram
Target Start Temperature (TST) The temperature that must be reached at the start of Occupancy.	[Analog Setpoint] 
Allowable End Temperature (AET) The temperature that must be maintained until the end of Occupancy.	[Analog Setpoint] 
Outside Air Temp (OAT) Current temperature of the ambient air outside the building.	[Analog Point] 
Inside Air Temperature (IAT) Current inside air temperature.	[Analog Point] 
Flow Temp (FT) Current temperature of the Conditioning medium (Heating or Cooling). While it is recommended that this be used, if the medium Flow Temperature is not available, this input can remain disconnected. (if this is the case, then the 'Sanity Check' condition described on page 8 will be ignored)	[Analog Point] 
Enable Input signal to enable or disable Optimiser operation. Does not disable Fabric Protection operation. If not connected then assumed to be enabled	[Digital Point] 

Note: Target Start Temperature (TST) and Allowable End Temperature (AET) can be derived from the Room Setpoint using the new Deadband module:



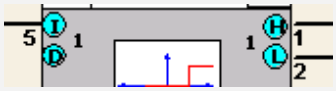
The Deadband module is a dual-channel module, in that it comprises two identical functions – allowing it to provide a deadband for heating and a deadband for cooling in a single module.

A “deadband” is a tolerance applied to a setpoint, such that if the measured temperature is outside that band the control algorithms are applied, but if the measured temperature is within the band control is not applied (control is ‘dead’).

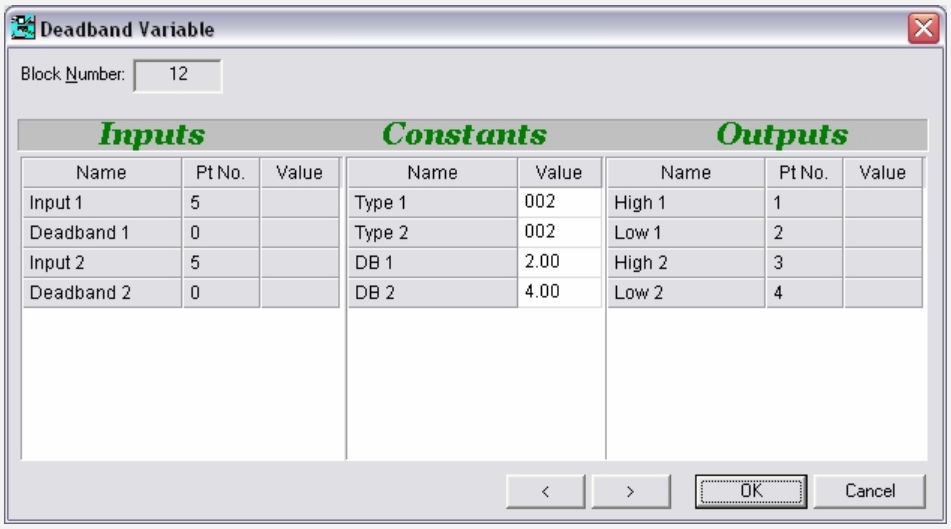


The “deadband” tolerance can be applied above the nominal value, straddling the nominal value or below the nominal value.

Each ‘channel’ of the Deadband module has a nominal value input (I), a Deadband input (D) (which overrides the internal ‘Deadband constant) and a High (H) and Low (L) output



The module dialog (opened by right-clicking on the module in the Strategy) shows the values of these parameters, as well as allowing Deadband type Type 1 002 and Deadband value DB 1 2.00 constants to be set for each “channel”. (The Deadband Value constant is overridden by the Deadband input (D), if the input is connected)

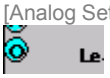


The Deadband Type value may be 1 (above the nominal value), 2 (straddling the nominal value) or 3 (below the nominal value).

Fixed Settings

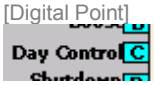
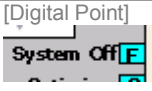
The following parameters are set within the Optimiser blocks themselves (right click on the module in the Strategy Drawing in the Engineering Tool to edit them). However, they can be overridden by external point values if required, by joining them to points in the Strategy drawing

Parameter Name parameter description	Nature Connector diagram
Occupancy A set of 7 on/off times, one for each day of the week, defining the times during which the building is occupied, i.e. the times during which the Building conditions are to be controlled.	Field Controller Schedule x7 
Flow Min Temp (FTmin) **Flow Max Temp (FTmax)** FTmin and FTmax define a range outside which the temperature of the conditioning medium must be before the start of Boost. FTmin is the bottom of this range, and FTmax is the top of this range. In Heating Optimisation, the flow temperature must be below the minimum temperature in the range, (i.e. below the value of FTmin) at the start, and must rise past the maximum temperature (FTmax) during the boost period. In Cooling Optimisation, the flow temperature must be above the temperature range before Boost, (i.e. above the value of FTmax) at the start, and must fall below the minimum temperature (FTmin) during the boost period. If the flow temperature does not meet these conditions before the start of Boost, the Learning process will not take place in the Optimiser (see page 8).	[Analog Setpoint]  [Analog Setpoint] 
Startup Temp (IATstart) If there is no historical data available (i.e when algorithm is initialised) this value is used as the limit value (minimum for heating, maximum for cooling) of the IAT at the start of the maximum Boost. (This value is only used once, to initialise the adaptive Model at start of Learning)	[Analog Setpoint] 
Boost Max Period The maximum time in minutes of the Startup (“Boost”) period	[Analog Setpoint] 
Falloffdown Max Period The maximum time in minutes of the Shutdown (“Falloff”) period	[Analog Setpoint] 
Deadtime (DT) If there is no historical data available (i.e when algorithm is initialised), this value (in minutes) is used as an estimate of the time between the start of heating or cooling action, and any corresponding change in temperature inputs. (This value is used once to initialise the adaptive Model at start of Learning, and in Fabric Protection)	[Analog Setpoint] 

Overlap Period If target temperature is not met by the start of Occupancy, this is the number of minutes for which Boost will continue to operate after the start of Occupancy to try and reach the target.	[Analog Setpoint] 
Linear Model A Value (A) **Linear Model B Value (B)** Linear Model parameters used initially by the Optimiser module to estimate Boost start time.	[Analog Setpoint]  [Analog Setpoint] 
Fabric Protection Min Temp (FPTmin) **Fabric Protection Max Temp (FPTmax)** "Fabric Protection" activates when temperature drops below FPTmin and continues to operate until temperature reacheds FPTmax. (Heating Block B only)	[Analog Setpoint] [Analog Setpoint] 

Outputs

The following values are generated by the Optimiser section of the Strategy:

Parameter Name parameter description	Nature Connector diagram
Demand This output indicates whether or not the conditioning plant should be active.	[Digital Point] 
Boost This indicates that conditioning plant should be operating at full capacity to achieve target temperature in the optimum time. This bypasses weather compensation etc.	[Digital Point] 
Day Control Status Indicates whether or not the Optimiser is in "Day Control" mode.	[Digital Point] 
Falloff Status Indicates whether or not the Optimiser is in Falloff ("Shutdown") mode. This output remains on for 3 hours, during which the Optimiser continues to monitor the Internal temperature falloff, to ensure the optimal falloff time is used.	[Digital Point] 
Time Schedule Status This output is intended to show when there is an ON signal from any of the Optimiser Time Schedule blocks. However, it is not enabled by default, in order to use it you must connect all of the Time Schedule Module outputs to the inputs on Optimiser Block B.	[Digital Point] 
System Off Flag This value is ON when neither the Optimiser nor Occupancy is in force.	[Digital Point] 
Optimiser Status	[Digital Point]

This shows when the Optimiser is in Startup mode – i.e Maximum Boost time plus overlap.

Error Status

Error indication. This value is ON if the sequence of Time Schedule and Optimiser blocks is not correct. When this value is ON, Optimiser operation is disabled, but Fabric Protection operation will still operate.

[Digital Point]

Learning Factor

This outputs the current value of the Learning Factor.

[Analog Point]

Predicated Boost Start Time

The value of this point is a "Decimal Time" representation of the time at which Boost will start. (e.g. 9.3 represents 9:30 am).

Note: this value is only updated when Optimiser Status is ON.

[Analog Point]

Predicated Falloff Start Time

The value of this point is a "Decimal Time" representation of the time at which Falloff will start. (e.g. 15.15 represents 3:15 pm)

Note: this value is only updated when Falloff Status is ON.

[Analog Point]

Time until Occupancy Start

This a "Decimal Time" representation of the time remaining until the start of Occupancy (e.g. 1.5 means 1 hour and 50 minutes remaining).

[Analog Point]

Time until Occupancy End

This a "Decimal Time" representation of the time remaining until the end of Occupancy (e.g. 7.35 means 7 hours and 35 minutes remaining).

[Analog Point]

Time Schedule Content outputs

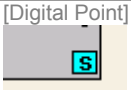
On Optimiser block B there are a number of outputs that provide useful information about Time Schedule settings. There is one pair for each of the Optimiser Time Schedule modules, showing the on time and off time for each schedule module, in "Decimal Time" (14.25 = 2:25 pm)

[Analog Points]

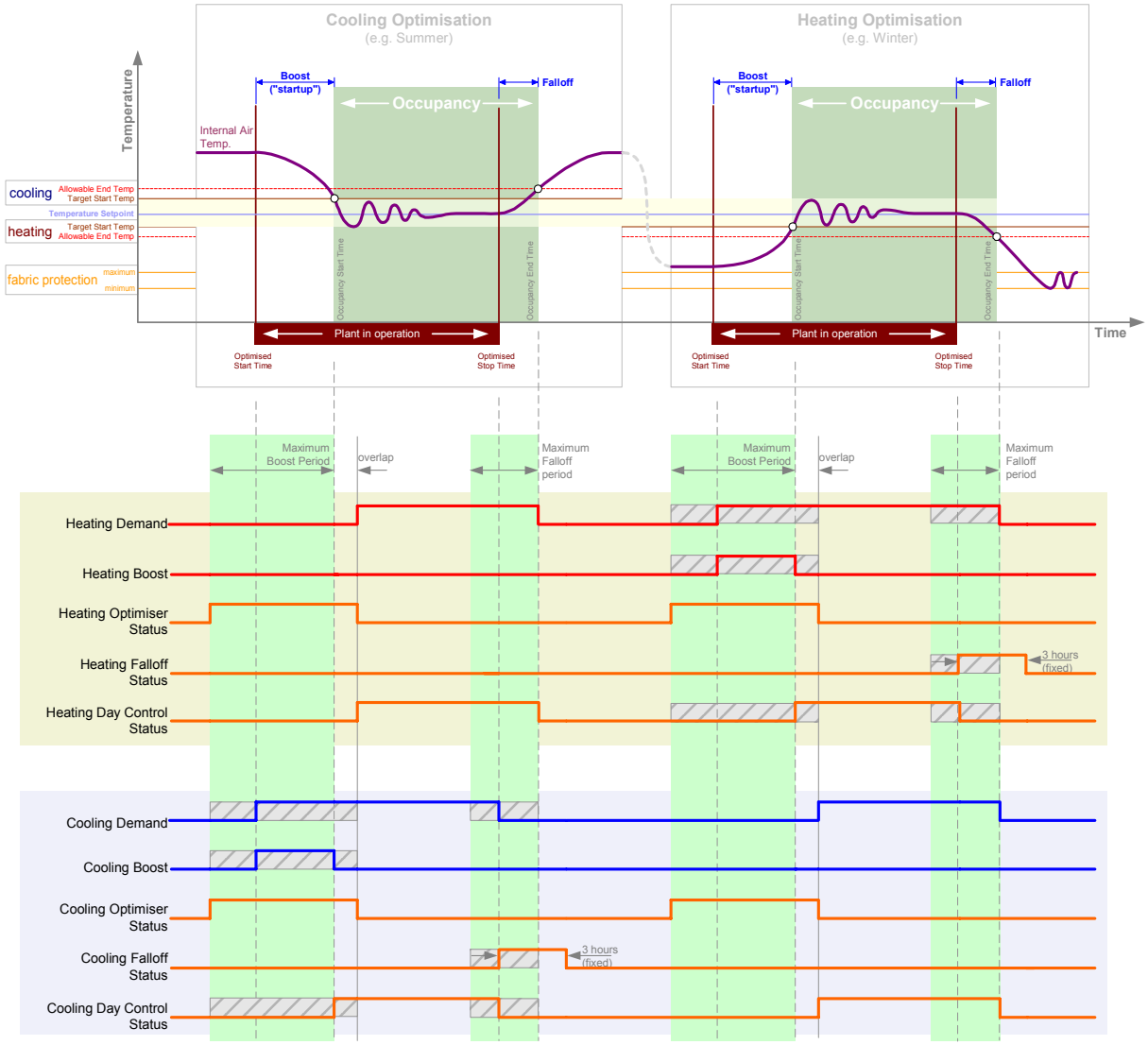
Fabric Protection Status

Indicates whether or not the Optimiser is in "Fabric Protection" mode. (Heating Block B only)

[Digital Point]



Output sequence

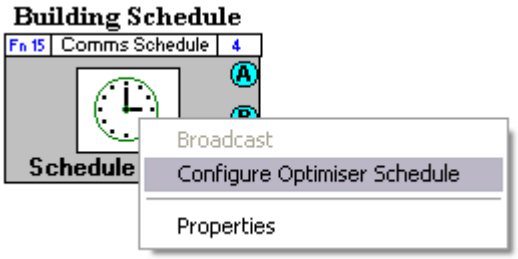


Automatic Updating of Optimiser times – linking to a Comms Controller Schedule

The 7 Time Schedule blocks in the Optimiser can be updated manually using the Unitron Engineering Centre. However, it is normally better to link them to the main building schedule, so that the Optimiser will respond to changes made by the End User.

This can be done by inserting a Comms Controller Time Schedule Global in the Strategy and linking it to the 7 consecutive Time Schedule blocks as follows:

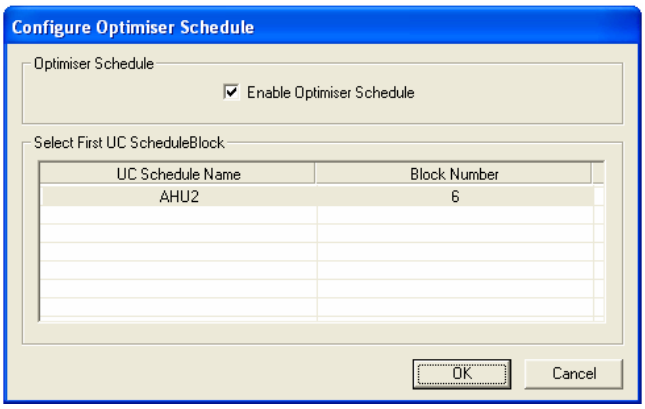
Right click on the Comms schedule **GLOBAL**, and the following context menu will be displayed:



The 'Configure Optimiser Schedule' item will be available if the module has no connecting lines AND one of the following is true:

- The **GLOBAL** has been previously been configured for use with an optimiser
- There are seven consecutive Field Controller time schedule blocks in the target strategy that are not being used by another optimiser.
- If this **GLOBAL** has **never** been set to "broadcast"

If the 'Configure Optimiser Schedule' item in the context menu is selected, the following dialog is displayed



The 'Enable Optimiser Schedule' check box sets whether or not this local schedule **GLOBAL** will link to Optimiser Schedules. When this is un-checked, the schedule list will be disabled.

When the dialog is first displayed, if the 'Enable Optimiser Schedule' box is ticked, and the current target schedule block for the optimiser can be selected from the schedule block list.

The 'OK' button on the dialog will be disabled if the 'Enable Optimiser' checkbox is ticked but there is no schedule block selected in the list – i.e. it will be impossible to link the Time Schedule Global to Optimiser Schedules without selecting a schedule block from the list.

Because an Optimiser must have its Time Schedules in consecutive blocks, the schedule block list will be populated with the first Field Controller time schedule from each group of 7 consecutive Field Controller time schedules. For example, if there are 7 consecutive Field Controller schedule blocks from block numbers 10 to 16, and another 7 from block numbers 28 to 34, then the first Field Controller schedule block from each group (block numbers 10 and 28) will appear in the list.

Once a local schedule **GLOBAL** module has been set to link to Optimiser Schedules, it will not be possible to link it to an individual point, i.e. It will not be possible to connect any lines to any of the module nodes.

Numbers of On/Off times in the Comms Controller Schedule

A UC32.net Communications Controller Time Schedule may contain many sets of on/off times per day.

A Field Controller Time Schedule module has two on/off times per day.

When a GLOBAL links a Comms Controller Schedule to a set of Field Controller schedules,

- the first set of on/off times in the Comms Controller schedule is written to the first on/off time in the corresponding Field Controller Schedule within the linked group.
- The second set of on/off times in the Comms Controller Schedule is written to the second on/off time in the relevant Field Controller Schedule. If the Comms Controller Schedule only has one set of times, the second on/off time in each UC32 Field Controller schedule will be zeroed.
- Any subsequent set of on/off times in the Comms Controller schedule are ignored.

Similarly, if an exception is in operation in the Comms Controller schedule, then the first exception on/off times will be written to the first on/off time in the relevant UC32 Field Controller schedule. If there is a second exception on/off time set then this is written to the second on/off time in the relevant UC32 Field Controller schedule, if not the second set of UC32 Field Controller on/off times is zeroed. Subsequent exception on/off times are ignored.

In a typical setup, the optimiser reads the first on/off time in the Field Controller Schedules, which is updated by the first set of on/off times in the Comms Controller schedule.

As a result, **only the first set of on/off times** in the Comms Controller schedule are relevant to the Optimiser.

Update Process

A linked Field Controller time schedule is updated daily from a Comms Controller time schedule. This is done with a two day lag so as not to affect the optimiser performance. If a UC32.net Communications Controller schedule which is associated with a UC32 Field Controller time schedule is downloaded (changed or not) an immediate update is carried out.

Normal Delayed Updating

At 00:01 each day all local GLOBALs are examined to see if they are optimiser-linked Time Schedule GLOBALs.

When such a GLOBAL is found, then the Comms Controller looks ahead to see if any exceptions will be coming into force over the following 5 days. If so, it loads the exception times into the relevant linked Field Controller Schedules immediately.

If an exception ceases to be in force, then the Standard times are re-loaded into the relevant Field Controller Schedules 2 days in arrears.

Handling exceptions in this way (loading 5 days in advance, and resetting 2 days in arrears) prevents interference with optimiser operation running over midnight, and results in a week lag in the exception times taking effect.

As a consequence, for Comms Controller Schedules that are linked to an optimiser by an optimiser-linked Time Schedule GLOBAL it is necessary to always enter exceptions at least 5 days in advance.

Note: If a UC32 Field Controller due for updating is off-line at 00:01, then it will be updated as soon as it comes back on-line - updating will not wait 24 hrs.

Immediate Change Updating

If a Comms Controller time schedule that is associated with a UC32 Field Controller Optimiser Schedule is changed, then a full week of the new standard times or the downloaded exception days are immediately sent to the linked Field Controller schedules - possibly altering its performance.

For an 'exception' schedule, if any exception day will be active within the next 7 days (including the current day), it will be downloaded immediately. This allows the week lag (see *Normal Delayed Updating* above) to be overridden. Any downloading of the Comms Controller Time Schedule is viewed as a change even if the actual times are not changed.

An ‘immediate’ update takes place on the next local global service after a delay of 1 min following the download. But if the local global is not “set up” the update will not be done.