PRESSURE BOOSTING IN COMMERCIAL BUILDINGS

SAVE UP TO 33% ENERGY

LEARN HOW YOU CAN SAVE ENERGY AND REDUCE COSTS BY OPERATING BOOSTERS IN PROPORTIONAL PRESSURE AND CONNECT MULTIPLE REMOTE PRESSURE SENSORS IN THE SAME SYSTEM.

FULL **CONTROL**

REDUCED **OPEX**

33% **ENERGY SAVINGS**

GRUNDFOS iSOLUTIONS

PUMP CLOUD SERVICES

Introducing multi-zone control of water systems means that shifting load scenarios can be handled effortlessly. In larger water systems, there may be end-users with very different water consumption profiles and pressure needs. So how do you satisfy all these pressure needs from the same booster set? Grundfos has developed a new multi-pressure zone control solution to achieve just that.

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Introduction

With Grundfos multi-zone control, several consumers can be monitored at the same time. This allows the booster to adapt pressure, even when consumption and critical points are shifting from one place to another, ensuring all consumers have sufficient pressure regardless of consumption. In addition, Grundfos has introduced proportional pressure for water boosting systems. Proportional pressure has become the de facto pump control standard in HVAC systems and can offer the same benefits to water boosting systems. Operating boosters in proportional pressure means substantial water and energy savings, and a more constant pressure regardless of water consumption.

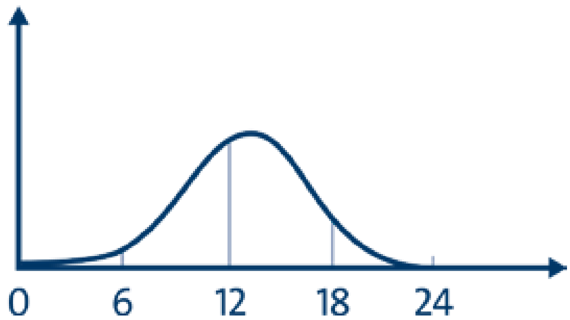
Water supply plant room in a commercial building.

1. Remote sensors in water boosting

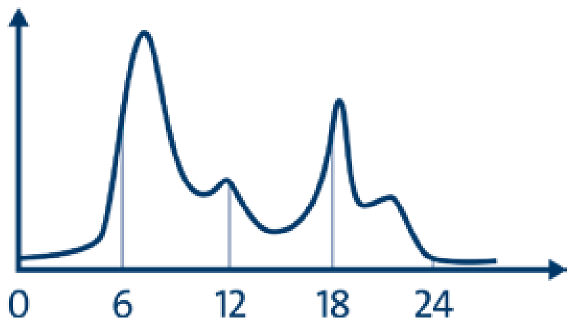
With Grundfos multi-zone control, one or more water consumers may be monitored at the same time.
This allows the booster to adapt pressure when the consumption and critical point are changing due to shifting consumption patterns.

Shifting critical point
In buildings with widespread water systems, such as an airport, there will most likely be water consumers with consumption profiles that are very different from one other. 1) A cooling tower's peak consumption is when aircon is active and ambient temperatures are high.
2) Water consumption in an airport hotel peaks during the morning. 3) Airplane wash water consumption is very unpredictable and may peak at any time of the day.
4) Ordinary consumption from public bathrooms and restaurants is relatively stable and constantly occurring.

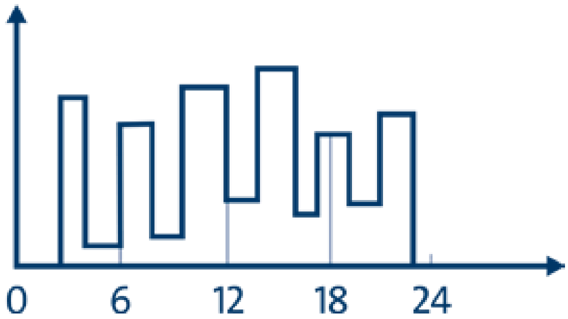
By installing separate remote pressure sensors for each potential critical point or water consumer, it's possible to adapt the water pressure to the need, regardless of where it may be located.



1) Cooling tower consumption profile



2) Airport hotel consumption profile



3) Airplane wash water consumption profile

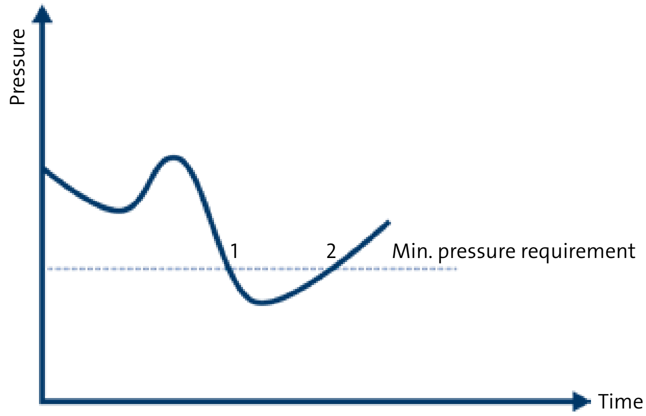
The booster controller continuously monitors the incoming signals and adapts performance to the exact sensor where the pressure requirement is highest. This means the booster 'follows' the critical point wherever that might be at any given time of day. And when there are no peak pressure requirements due to low consumption, the booster will reduce performance to what's needed to deliver the minimum requirements for the critical point.

Where is the critical point?
During design of large water systems, the critical point needs to be defined in order to select and size the water booster as well as the pipes. This requires a total pressure loss calculation of the system where both static and dynamic losses from pipes, bends and components are taken into account. If there are several locations in the system that are potentially the critical point, a way of getting around lots of calculations is to install more than one remote sensor. There may be up to six sensors installed at critical points, which could be located at high points in the system, where a large consumer is located, or simply at the system's furthest point.

An example of a commercial building with a widespread water system. It can be challenging to determine the critical point, so up to six pressure sensors will be enough to cover the entire system.

Pressure maintenance with Hydro MPC
Before system start up, it's important to consider how the pressure will be maintained. Is there both a minimum and maximum pressure requirement, or only a minimum requirement?

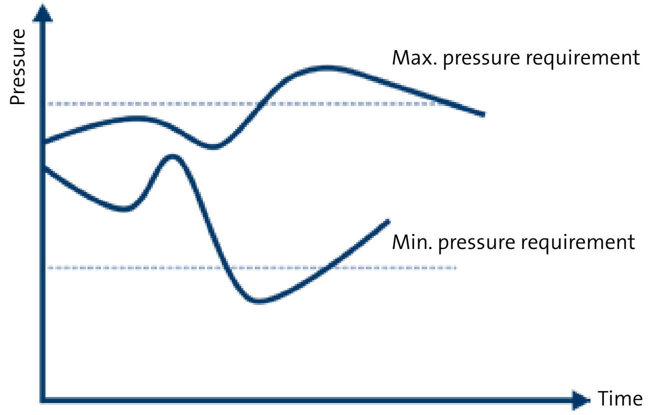
Maintain a minimum pressure
When "minimum mode" is selected, the booster will maintain a minimum pressure regardless of the water consumption. If the pressure at one or more of the sensors is below the preset requirement, the booster will ramp up until all sensors are above the limit. Minimum mode can also be applied in systems with one remote sensor, or where the sensor is located on the pump manifold.



If the pressure at one or more of the sensors is below the preset requirement, the booster will ramp up until all sensors are above the limit.

Maintain a minimum and maximum pressure
When "priority mode" is selected, the booster will maintain a minimum and maximum pressure regardless of the water consumption. This control mode is applied in systems with more than one remote sensor, and where there's both a minimum and maximum pressure requirement.

In this case, a situation might occur where one sensor will try to increase booster performance while another will try to decrease it. A prioritisation of the sensors therefore needs to be carried out during commissioning, based on the water consumers' importance and pressure criticality.



Priority mode may be applied in systems with more than one remote sensor and where there's both a minimum and maximum pressure requirement.

Hydro MPC set up
It's easy to set up a system with several sensors using the MPC display.

Multi-sensor main menu:
- Set the number of sensors. Up to six remote sensors may be defined here.
- Set the controller's setpoint limits. This is the overall pressure setting that the booster is allowed to operate within. It should never exceed the pressure rating of any system component. Also be aware of operating pressures of PRV´s.
- Optionally adjust controller settings based on distance to the sensors. Consult the guide in Hydro MPC installation manual.
- Select the energy saving mode. This ensures the booster will always ramp down to the lowest possible pressure requirement or the minimum setpoint limit.
- Set the control mode to either minimum or priority mode.

Multi-sensor main menu

Individual sensor menu:
- Enable or disable the individual sensor.
- Define sensor name.
- Set the individual sensor limits. This is the pressure requirement relevant for the consumer where the sensor is located.
- Set the sensor priority.
- Filter factor. A low-pass smoothing of the measured value which results in a more stable setpoint calculation.

Individual sensor set up menu

When critical point is well known
If the critical point is well defined and there's no major single consumer, a single remote sensor serving as primary sensor may be installed at the system's critical point. When using an external sensor at the critical point, the pressure at this location is guaranteed, regardless of consumption and pressure losses.

Secondary sensor
If the sensor signal is lost due to a cable break, sensor fault or a bad connector, the booster will switch over to a secondary sensor installed on the booster manifold system. To utilise this functionality, the secondary sensor's pressure requirements will have to be set up. Here, static lift as well as dynamic pressure loss in the system will need to be included in the pressure requirement (setpoint). Operating the booster based on a secondary sensor sitting on the manifold will always lead to additional pump energy consumption. This is because the approach doesn't compensate for declining dynamic losses when consumption is low.

Secondary sensor set up menu

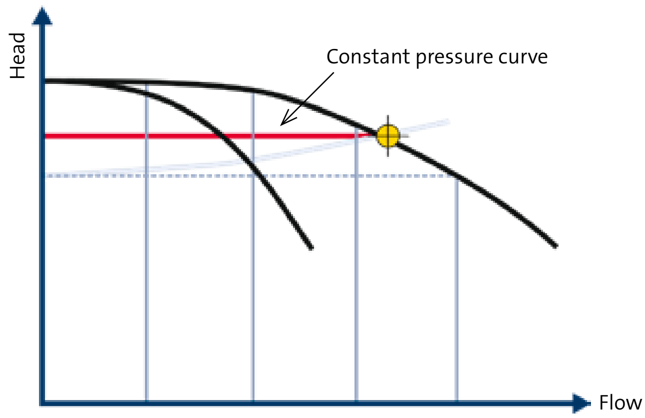
2. Proportional pressure in general

Proportional pressure control decreases pressure at low flow demands and increases the pressure at high flow demands to compensate for dynamic friction losses.

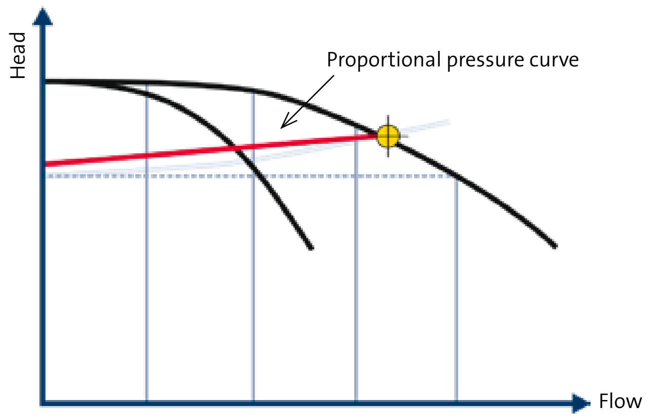
Static and dynamic losses
When sizing any water boosting pump, static height and dynamic losses need to be calculated. The static head is determined as the elevation from the booster's discharge port to the highest tapping point in the building or boosting zone. In other words, the static head is always present regardless of water consumption. On the other hand, dynamic losses depend on the water flow. The more flow in the system, the more dynamic losses in pipework and fittings. The total head provided by the booster needs to overcome both static height, dynamic losses as well as over-pressure at the tap.

Water pressure at the tap
Adequate water pressure is crucial to the water flow through an open tap – normally between 1.5-2 bar. Here, the water will leave the tap at a reasonable flow rate. Increased pressure won't increase consumer comfort – it simply increases water and power consumption.

Ratio between static and dynamic losses
As dynamic losses in water systems are often regarded as almost non-existent, water boosting systems are operated in constant pressure mode, despite the fact that dynamic pressure is variable. Running the system in constant pressure may be an easy decision to take, such as in a tall building with lots of static head, because dynamic losses seem insignificant. However, if you're looking for savings, you'll need to consider proportional pressure.

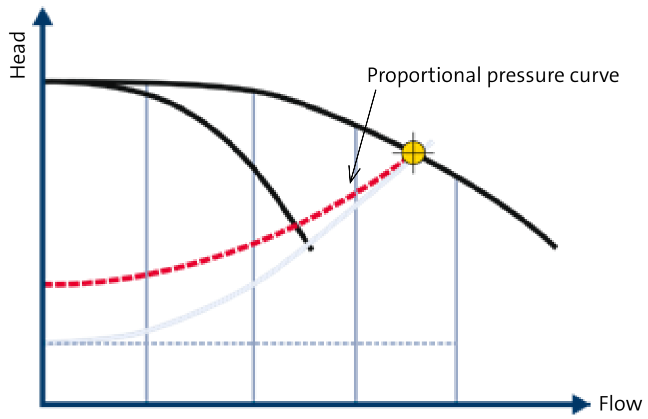


Dynamic losses compared to static height may seem insignificant in tall buildings, but this isn't the case at all. Dynamic losses are the cause of a higher energy bill as the booster is set to constant pressure regardless of flow and dynamic losses.



Here, the booster is set to proportional pressure mode, meaning the booster adapts to the pressure requirements.

Most commercial buildings, however, aren't tall buildings which means that static losses are reduced, and in many cases the dynamic and static losses ratio are turned upside down. Where dynamic losses are dominant over static losses, proportional pressure becomes extremely relevant.



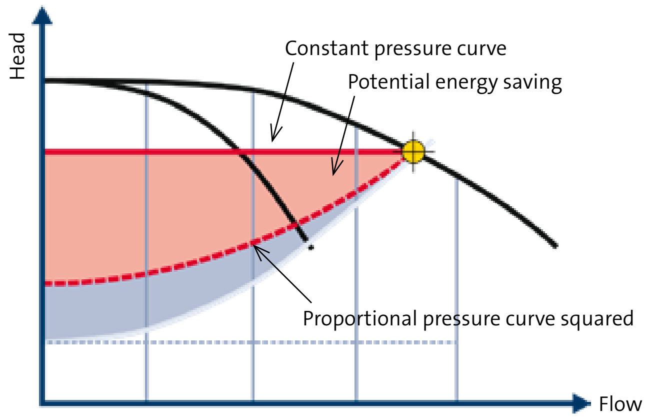
In this example, the static and dynamic loss ratio is turned upside down. An airport is characterised by only a few floors and long distances, making proportional pressure even more relevant.

Proportional pressure mode = constant water flow

Water systems running in proportional mode are able to adjust the pressure to the actual need. When the system flow is reduced, the pressure is reduced proportionally as well. In this case, the water pressure at the tap is close to constant so there's only a marginal water overspend in low flow situations. If the booster is operated in constant pressure mode, the available pressure will increase as consumption and dynamic pressure reduces.

3. Proportional pressure with Hydro MPC

Proportional pressure mode comes as standard with the Grundfos Hydro MPC booster and can also operate ***without remote sensors in the system***. In this case, the controller operates based on a pressure sensor placed on the booster's outlet manifold. Once the controller is programmed with the percentage of the friction head and the preferred adaptation mode (linear or square), it will automatically adjust the head to compensate for the friction loss seen in the system.



The Grundfos Hydro MPC can operate in two different proportional pressure modes: a linear adaption to the dynamic losses, and a squared one which simulates real system conditions with a remote sensor. The red area illustrates the potential energy savings achieved with squared proportional pressure.

Setting up proportional pressure

Setting up proportional pressure mode on the Grundfos Hydro MPC is an easy task. In the MPC user interface you're in total control of pump performance at any flow, as well as the steepness of the control curve, regardless of whether the booster is operated in linear or squared mode.

As an example, if the required head is 25 bar at design flow and the required head at zero flow is 15 bar, "influence at 0 flow" should be calculated as follows: 100% – (25-15) / 25 = 60%. In this case, the booster will reduce its performance to 60% (equalling 15 bar) of the required pressure in the design flow. However, always keep in mind that the pressure at zero flow should never be less than the static height + water pressure at the tap – minimum inlet pressure.

Hydro MPC proportional pressure set up menu. Additionally, a maximum flow rate may be defined. This ensures the system flow will not exceed the system's nominal flow.

Savings with proportional pressure
To make things clear, let's compare the two control modes we've been discussing: constant pressure, and proportional pressure based on a remote sensor. We'll use a 90m tall commercial building with a design water flow of 35 m^3/h.

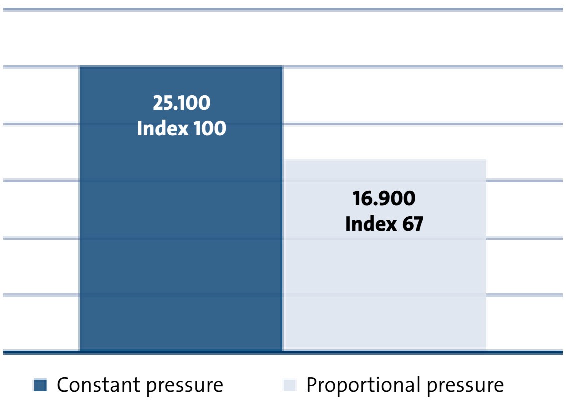
A commercial building with a static and dynamic loss ratio of 50/50. Dynamic pressure loss is based on 500m of water pipe with a specific pressure loss of 450 Pa/m plus losses in components.

The water booster system in the building has the following data:

- Static pressure loss: 40 mwc or 390 kPa
- Dynamic pressure losses: 390 kPa
- Pressure at the tap: 150 kPa
- Design pump head: 930 kPa
- Design water flow: 35 m3/h

Using the online Grundfos Product Center for product selection and sizing, a two-pump Hydro MPC-E CRE20-6 is chosen and the annual energy consumption calculated. Operating the pump in proportional pressure mode achieves an annual power saving of 33% compared to constant pressure control. At zero flow, the booster performance may be reduced to 58% (influence at 0 flow) of the design pump head.

Power consumption, kWh



By operating the booster in proportional pressure mode, the annual power saving in this case is 33% without ever compromising consumer comfort.

Advantages to proportional pressure
There are several advantages to proportional pressure:

- Comfort: in a system with proportional pressure, the booster adapts the pump head to the actual need. The consumer will therefore experience a more constant water flow in the tap at any time.
- Water savings: the pump head can be turned down to the actual pressure required, helping save water.
- Energy savings: lower system pressure means lower energy cost.
- Reduction of wear and tear on pipes, fittings, valves and pumps.

4. Integration of Hydro MPC to a Building Management System (BMS)

The Grundfos Hydro MPC easily integrates with building management systems for optimal monitoring and remote control.

For complete control of pump systems, the Grundfos fieldbus concept is the right solution. The innovative Communication Interface Module (CIM) enables data communication via open and interoperable networks based on RS485 or Ethernet.

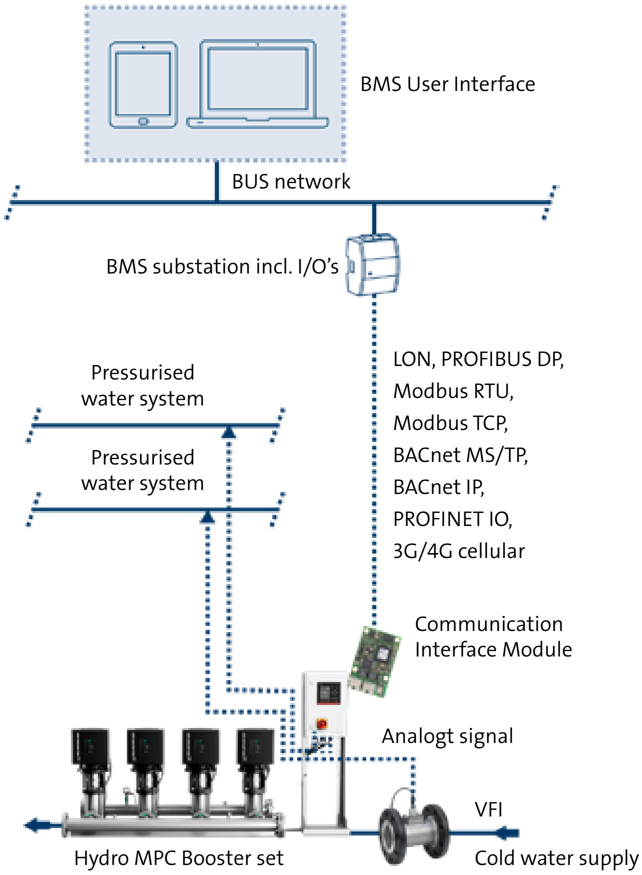
The series of Grundfos CIM/CIU communication interfaces offers ease of installation and commissioning, user-friendliness and great value for money. All modules are based on standard functional profiles for simple integration into the network and easy understanding of data points.

Grundfos Communication Interface Modules (CIM) enable communication via all relevant fieldbuses.

The Grundfos fieldbus solution covers and supports a wide range of open and interoperable networks, including:

- LONworks
- PROFIBUS DP
- PROFINET
- Modbus RTU
- Modbus TCP
- BACnet MS/TP
- BACnet IP
- EtherNet/IP
- 3G/4G Cellular
- Grundfos iSOLUTIONS Cloud (updated version will be available during 2019)

Grundfos constantly upgrades and expands the fieldbus communication portfolio. Go to the Grundfos homepage or contact your local Grundfos specialist.

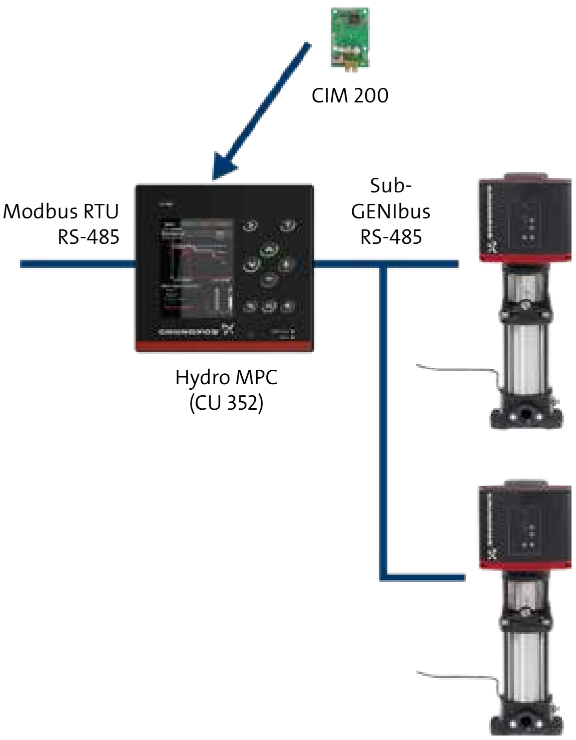


Example of a Hydro MPC set up connected to a BMS system.

The Grundfos fieldbus solution, the CIM module, enables data communication for various purposes such as:

- Booster remote monitoring
- Receival of warnings and alarms
- Change of operating mode

- Change of setpoint
- Change of control mode
- Pump speed
- Power/energy consumption



Example of a Hydro MPC with a Modbus RTU fieldbus.
The CIM is installed inside the controller.

Here are some examples of system control and monitoring:

Commands:
- System on/off
- Set the control mode
- Change the setpoint
- Set the individual pumps in auto or off
- Reset alarms

System status:
- Actual set point
- Values on all analogue inputs
- Status on digital in/output
- Power consumption
- Total running hours
- Total energy consumption

Individual pump status:
- Alarms
- Operation time
- Pump speed
- Line current
- Power uptake