Draft Version: 0.92
Pump Controller Object: xxxx
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LONMARK Functional Profile:

Pump Controller Object for HVAC Applications

Overview

This functional profile describes a Pump Controller Object for a variable speed pump.

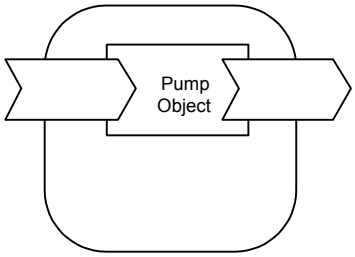


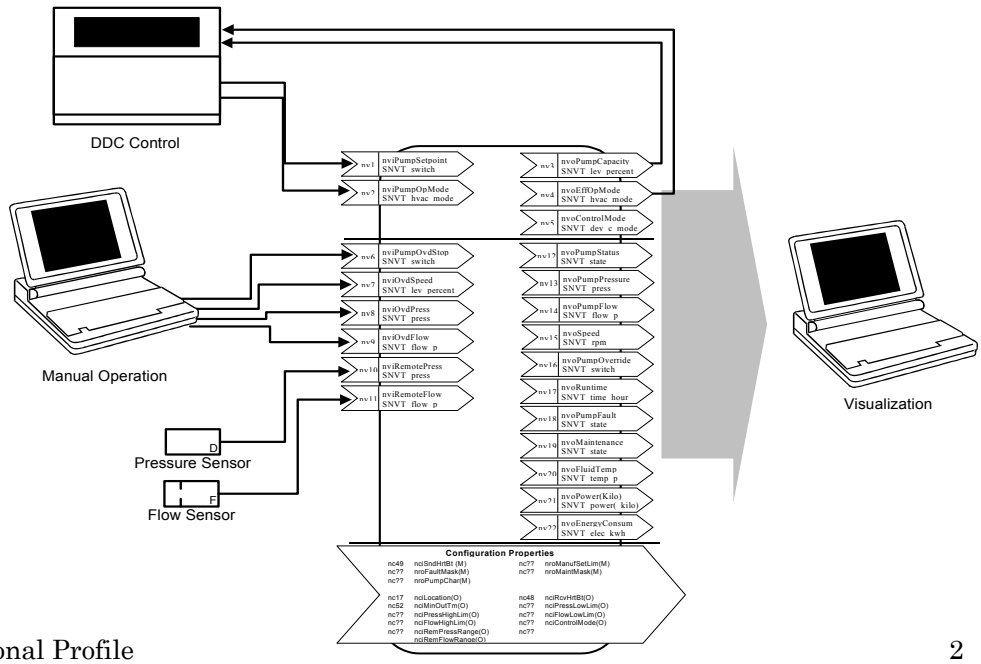
Figure 1.1 Functional Profile

Example Usage

Utilization of the LONMARK Pump Controller Object Profile facilitates interoperability between the pump controller and other control devices from multiple vendors. The Pump Controller Object will reside in a node on a LONWORKS network and its network variables can be bound to other controllers, operator interface devices, energy management systems, etc.

For example, an air handling unit controller may send messages over the network to start and stop or control the speed, pressure or flow of the pump. The pump controller may output messages such as the actual pump speed, pump pressure and status information to the controller, operator interface devices and energy management systems. A network management tool will be used to install the pump controller node on the network and bind the network variables to other devices on the network.

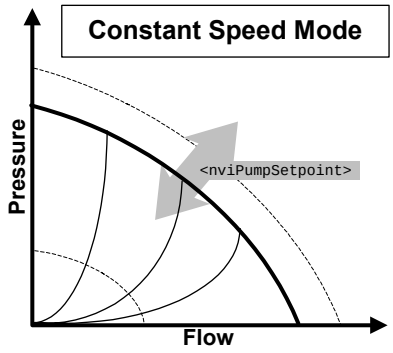
Implementation of this Pump Controller Object profile allows the pump manufacturer to apply for LONMARK certification and approval to display the LONMARK symbol on the equipment housing and documentation.



Example Usage

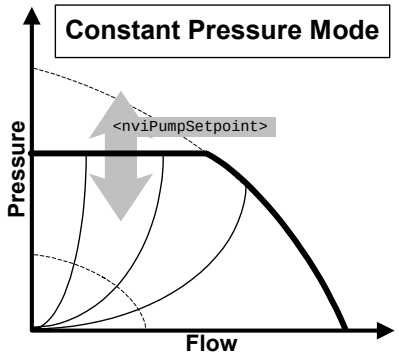
A pump provides the primary force to distribute and circulate hot and chilled water in a variety of space temperature and air conditioning systems. Simple pumps operate at one speed only and can be switched on or off. A pump with an intelligent controller can operate at a variable speed. The capacity of the pump can be controlled in several different ways.

The simplest way is to control the speed of the pump. In this case the pump works in the ”Constant Speed Mode” and the setpoint of the pump is interpreted as the required speed.

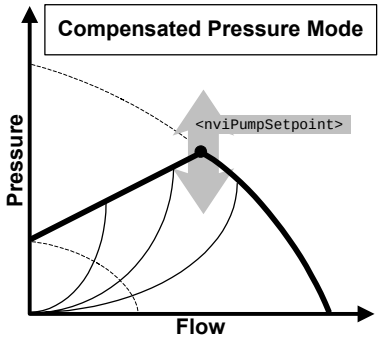


Another way to control the capacity of the pump is to vary the speed to maintain a certain pressure. The pressure can be calculated or measured internally in the pump and controller assembly, or remotely measured by a differential pressure sensor in the piping system.

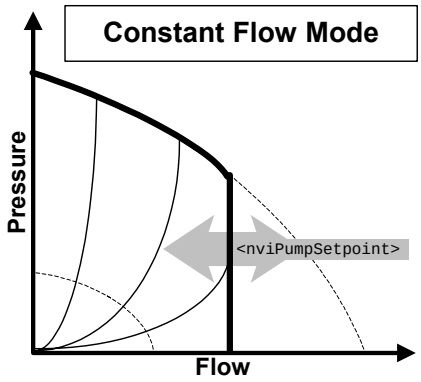
There are two pressure control modes. The first pressure control mode is the ”Constant Pressure Mode” where the setpoint of the pump is interpreted as the required pressure and is independent of the flow.



The second pressure control mode is the ”Compensated Pressure Mode”, where the setpoint of the pump is interpreted as the required pressure at maximum speed. The pressure setpoint is reduced by the controller in a proportional manner between maximum and minimum pump capacity. The actual method of compensating the pressure setpoint by pump speed or flow is determined by the manufacturer.



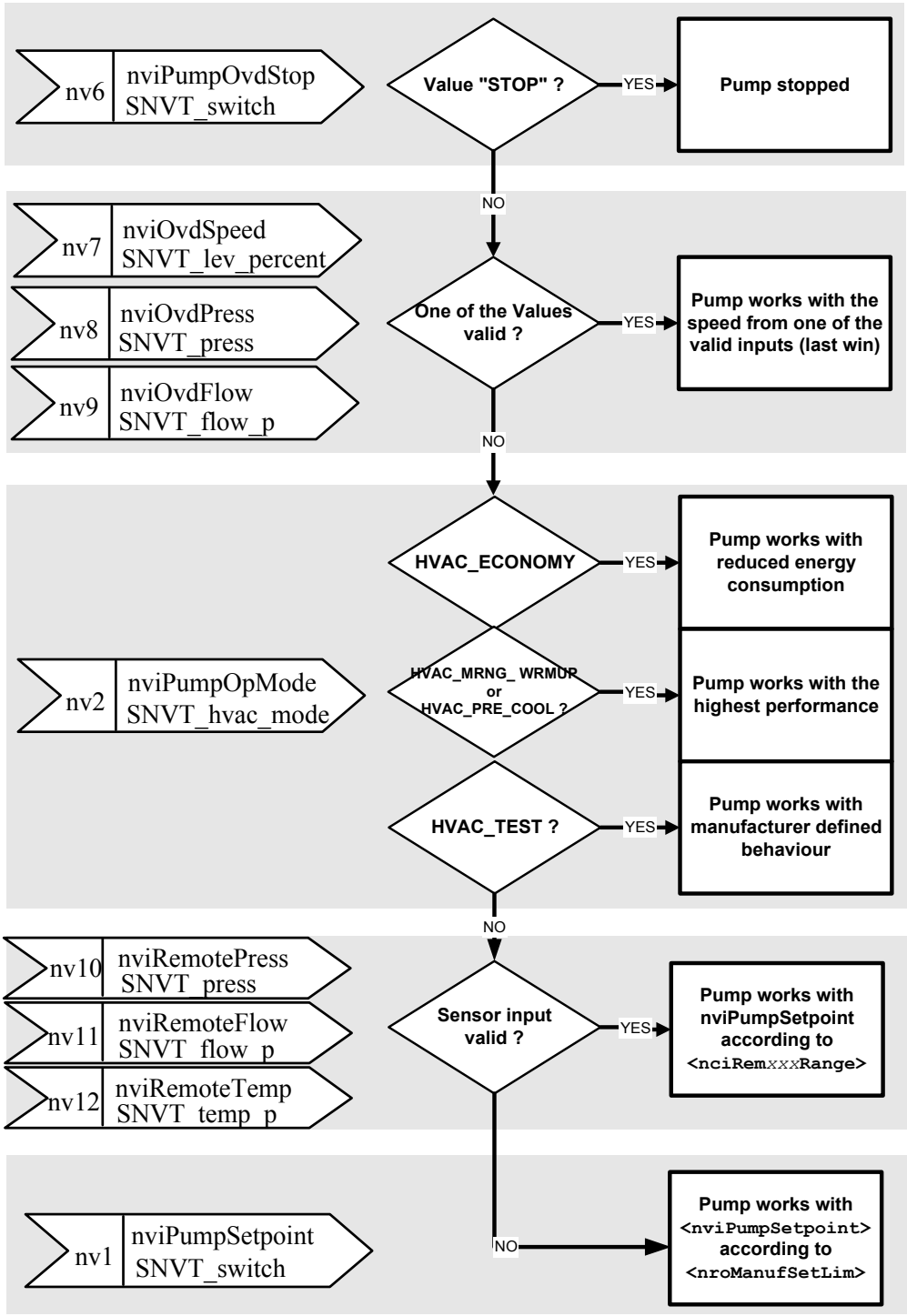
Yet another way to control the capacity of the pump is to vary the speed to maintain a certain flow. In ”Constant Flow Mode”, the setpoint of the pump is interpreted as the required flow and is independent of the pressure. The flow can be calculated or measured internally in the pump and controller assembly, or remotely measured by a flow sensor in the piping system.



An other way to control the capacity of the pump Is to vary the speed to maintain a certain temperature. This temperature can be the return water temperature by a hot water heating system. The setpoint of the pump Is Interpreted as the required temperatur.

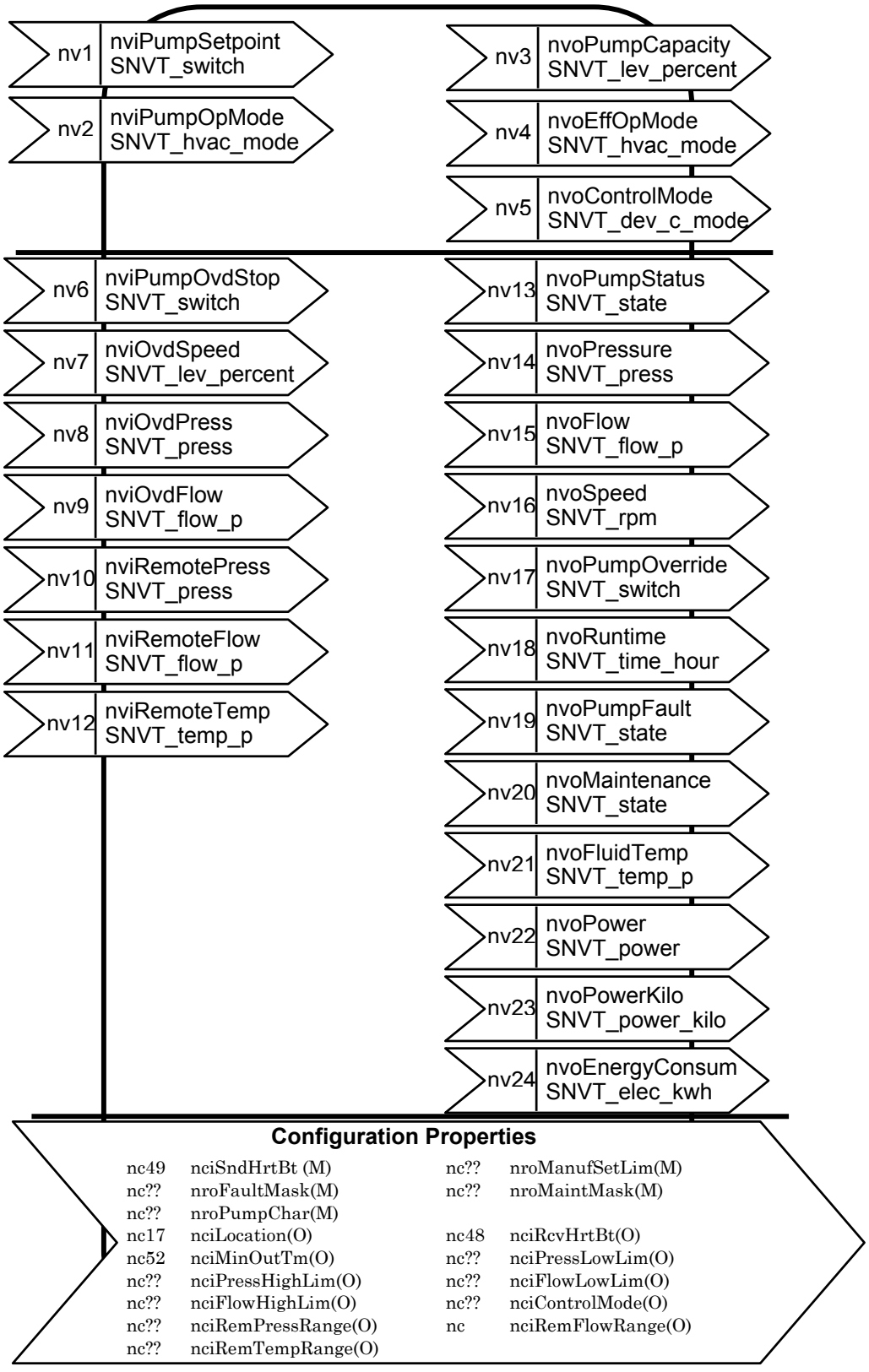
The user can also set the pump into special operating modes. These modes are designed to save energy by reducing the pump capacity to the minimum (HVAC _ECONOMY) or to bring the controlled space more quickly into the comfort condition by increasing the pump capacity to the maximum value (HVAC_MRNG_WRMUP).

The Pump Controller Profile includes input network variables to manually override the operation of the pump. A valid value on any one of these input variables sets the pump into the override mode. The pump will not return to normal setpoint control until all manual override inputs are invalid. The priority of the various override inputs can be seen in the following diagram.



Object Details Note:

The Pump Controller Object for HVAC applications is shown in the figure below.



Pump Controller Object Details

Table 2.1: Network Variable Inputs

NV # (M/O)**	Name	Recv HrtBt	SNVT Type	SNVT Index	Class	Description
1 (M)	nviPumpSetpoint	No	SNVT_switch	95	RAM	Pump setpoint for normal operation
2 (M)	nviPumpOpMode	No	SNVT_hvac_mode	108	RAM	Requested pump operating mode
6 (O)	nviPumpOvdStop	No	SNVT_switch	95	RAM	Pump override stop command
7 (O)	nviOvdSpeed	No	SNVT_lev_percent	81	RAM	Override setpoint for speed
8 (O)	nviOvdPress	No	SNVT_press	30	RAM	Override setpoint for pressure
9 (O)	nviOvdFlow	No	**SNVT_flow_p**	**TBD**	RAM	Override setpoint for flow
10 (O)	nviRemotePress	Yes	SNVT_press	30	RAM	Remote differential pressure sensor
11(O)	nviRemoteFlow	Yes	**SNVT_flow_p**	**TBD**	RAM	Remote flow sensor
12(O)	nviRemoteTemp	Yes	SNVT_temp_p	105	RAM	Remote temperature sensor

Pump Controller Object Details

Table 2.2: Network Variable Outputs

NV # (M/O)**	Name	Send HrtBt	SNVT Type	SNVT Index	Class	Description
3 (M)	nvoPumpCapacity	Yes	SNVT_lev_percent	81	RAM	Pump capacity as percent of maximum
4 (M)	nvoEffOpMode	Yes	SNVT_hvac_mode	108	RAM	Effective operating mode
5 (M)	nvoControlMode	Yes	**SNVT_dev_c_mode**	**TBD**	RAM	Effective device control mode
13 (O)	nvoPumpStatus	Yes	SNVT_state	83	RAM	Pump status diagnostic information
14 (O)	nvoPressure	No	SNVT_press	30	RAM	Pump pressure
15 (O)	nvoFlow	No	**SNVT_flow_p**	**TBD**	RAM	Pump flow
16 (O)	nvoSpeed	No	SNVT_rpm	102	RAM	Pump speed
17 (O)	nvoPumpOverride	No	SNVT_switch	95	RAM	Pump override active
18 (O)	nvoRuntime	No	SNVT_time_hour	124	RAM	Runtime in hours
19 (O)	nvoPumpFault	No	SNVT_state	83	RAM	Fault states of the pump
20 (O)	nvoMaintenance	No	SNVT_state	83	RAM	Maintenance states of the pump
21 (O)	nvoFluidTemp	No	SNVT_temp_p	105	RAM	Fluid temperature
22 (O)	nvoPower	No	SNVT_power	27	RAM	Electrical power consumption in watts
23 (O)	nvoPowerKilo	No	SNVT_power_kilo	28	RAM	Electrical power consumption in kilowatts
24 (O)	nvoEnergyConsum	No	SNVT_elec_kwh	13	RAM	Total energy consumption of the pump

** M = mandatory, O = optional

Pump Controller Object Details

Table 2.3: Configuration Properties

Config. Property # (M/O)**	Name	SCPT Index	SNVT Type (SNVT Index)	Class	Description
1 (O)	nciLocation	17	SNVT_str_asc (36)	NVM	Location Label
2 (O)	nciRcvHrtBt	48	SNVT_time_sec (107)	NVM	Receive Heartbeat Time
3 (M)	nciSndHrtBt	49	SNVT_time_sec (107)	NVM	Send Heartbeat Time
4 (O)	nciMinOutTm	52	SNVT_time_sec (107)	NVM	Min Send Time
5 (O)	nciPressLowLim	TBD	SNVT_press (30)	NVM	User defined Pressure Low Limit
6 (O)	nciPressHighLim	TBD	SNVT_press (30)	NVM	User defined Pressure High Limit
7 (O)	nciFlowLowLim	TBD	**SNVT_flow_p (TBD)**	NVM	User defined Flow Low Limit
8 (O)	nciFlowHighLim	TBD	**SNVT_flow_p (TBD)**	NVM	User defined Flow High Limit
9 (O)	nciControlMode	TBD	**SNVT_dev_c_mode (TBD)**	NVM	Control mode for normal operation
10 (O)	nciRemPressRange	TBD	N/A	NVM	Remote pressure sensor range
11 (O)	nciRemFlowRange	TBD	N/A	NVM	Remote flow sensor range
12 (O)	nciRemTempRange	TBD	N/A	NVM	Remote temperature range
13 (M)	nroManufSetLim	TBD	N/A	NVM	Manufacturer defined setpoint limits
14 (M)	nroFaultMask	TBD	SNVT_state (83)	NVM	Fault states mask
15 (M)	nroMaintMask	TBD	SNVT_state (83)	NVM	Maintenance states mask
16 (M)	nroPumpChar	TBD	N/A	NVM	Pump Characteristics

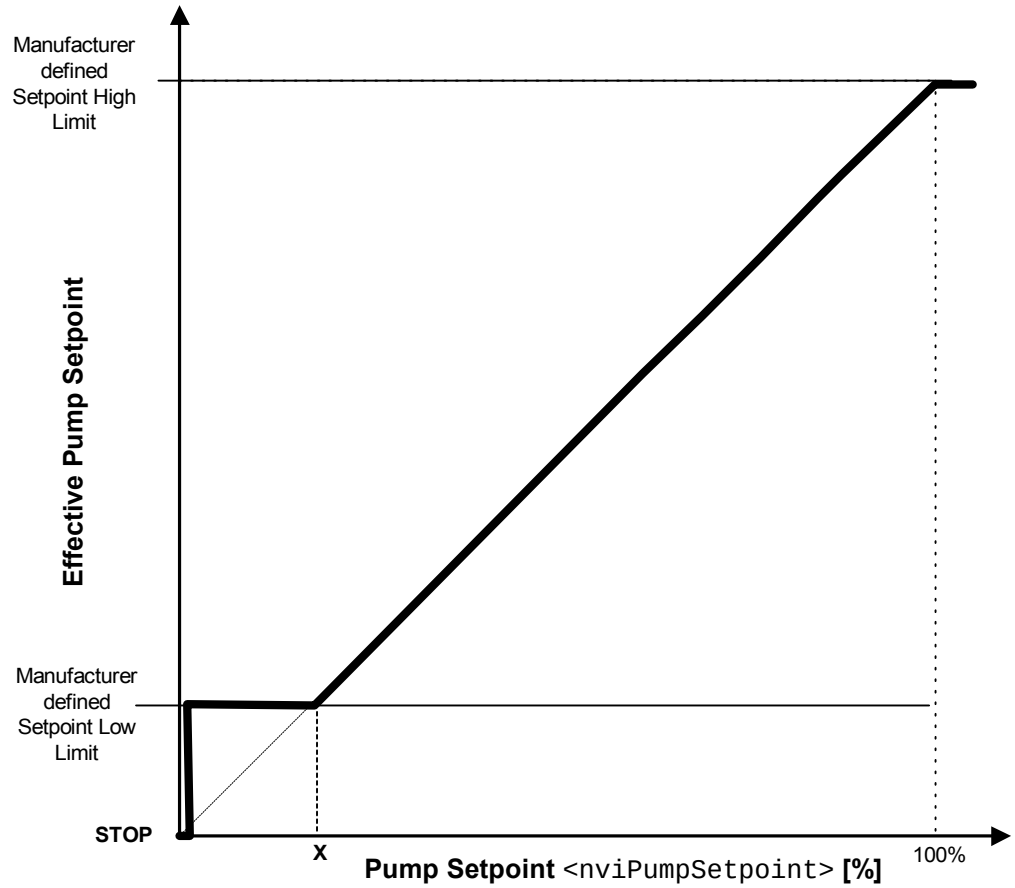
** M = mandatory, O = optional

Mandatory Network Variables

Pump Setpoint

```
network input SNVT_switch nviPumpSetpoint;
```

This input network variable provides start/stop control and a setpoint. The setpoint is given as a percentage of the effective maximum value (max = 100%). The setpoint value can represent the pump speed, the pressure or the flow, depending on the Effective Operating Mode of the pump <nvoControlMode>.



X = (Manufacturer defined Setpoint Low Limit / Manufacturer defined High Limit) * 100%

or

X = (Remote Sensor Range Low Value / Remote Sensor High Value) * 100%

For example, if the control mode is constant pressure (<nvoControlMode> =PRESS_CONST) and the maximum pressure limit is 100 kPa, a setpoint of 20% means the pump has to produce 20% of 100 kPa = 20 kPa. The setpoint values will also be affected by the User-defined Low Limit and the High Limit configuration properties.

The <nvoPumpCapacity> always shows the actual pump capacity as a percentage of the effective maximum value.

Valid Range

Control Mode	Value Type
0 = SPEED_CONST	The speed of the pump ==> (<nviPumpSetpoint>/100%)x<nroManufSetLim.SpeedMax>)
1 = PRESS_CONST	The constant pressure setpoint of the pump ==> (<nviPumpSetpoint>/100%)x<nroManufSetLim.PressConstMax>)
2 = PRESS_COMP	The compensated pressure setpoint of the pump ==> (<nviPumpSetpoint>/100%)x<nroManufSetLim.PressCompMax>)
3 = FLOW_CONST	The constant flow setpoint of the pump ==> (<nviPumpSetpoint>/100%)x<nroManufSetLim.Flow ConstMax>)
5 = TEMP_CONST	The constant temperature setpoint of the pump ==> (<nviPumpSetpoint>/100%)x<nroManufSetLim.TempConstMax>)

For n-state Pumps:

State	Value	Equivalent Percent	Requested Speed
0	n/a	n/a	STOP
1	0	0%	STOP
1	1 to (1/n)200	0.5% to (1/n)100.0%	Pump speed #1
1	1 + (1/n)200 to (2/n)200	0.5% + (1/n)100.0% to (2/n)100%	Pump speed #2
1	1 + ((m-1)/n)200 to (m/n)200	0.5% + ((m-1)/n)100.0% to (m/n)100%	Pump speed #m
1	1 + ((n-1)/n)200 to 200	0.5% + ((n-1)/n)100.0% to 100%	Pump speed #n

For variable speed Pumps:

State	Value	Equivalent Percent	Requested Speed
0	n/a	n/a	STOP
1	0	0%	STOP
1	1 to 200	0.5 to 100.0%	0.5 to 100.0%
1	201 to 255	100.0%	100.0%

Default value

Default value is manufacturer defined. This value will be adopted at power-up.

Requested Pump Operating Mode

```
network input SNVT_hvac_mode nviPumpOpMode;
```

This input network variable is typically used by a supervisory controller to override the pump controller operating mode. If a mode is requested that is not supported by the unit, the unit will treat it as an invalid value. When a valid value is present (other than HVAC_AUTO), it will take precedence over any locally wired input that calls for a different mode, and the requested mode will be shown as the Effective Operating Mode (nvoEffOpMode).

When the mode is HVAC_AUTO, the network variable input `<nviPumpSetpoint>` defines the working setpoint of the pump. When the mode is HVAC_MRNG_WRMUP or HVAC_PRE_COOL, the pump typically operates at maximum capacity. The actual behavior is manufacturer defined.

For energy saving at night, in the summer or under low load conditions, the mode HVAC_ECONOMY may be used. The pump typically operates in this mode at minimum capacity or with reduced energy consumption. The actual behavior is manufacturer defined.

For test purposes the mode HVAC_TEST may be used. The actual behavior in this mode is manufacturer defined.

Valid Range

0	**HVAC_AUTO**	**Normal operation**	**`<nviPumpSetpoint>` defines the effective setpoint**
1	HVAC_HEAT	not supported	
2	**HVAC_MRNG_WRMUP**	**Morning warmup**	**maximum capacity mode (Manufacturer defined)**
3	HVAC_COOL	not supported	
4	HVAC_NIGHT_PURGE	not supported	
5	**HVAC_PRE_COOL**	**Morning cooldown**	**maximum capacity mode (Manufacturer defined)**
6	HVAC_OFF	not supported	
7	**HVAC_TEST**	**Equipment being tested**	**(Manufacturer defined)**
8	HVAC_EMERG_HEAT	not supported	
9	HVAC_FAN_ONLY	not supported	
10	HVAC_FREE_COOL	not supported	
11	HVAC_ICE	not supported	
12	HVAC_MAX_HEAT	not supported	
13	**HVAC_ECONOMY**	**Energy saving**	**minimum capacity mode (Manufacturer defined)**
0xFF	**HVAC_NUL**	**Invalid value**	

Default value

Default value is HVAC_AUTO. This value will be adopted at power-up.

Pump Capacity

```
network output SNVT_lev_percent nvoPumpCapacity;
```

This output network variable provides the actual pump capacity as a percentage of the effective maximum setpoint value.

Valid Range

-163.84% .. 163.83% (0.005% or 50 ppm). The value 0x7FFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (manufacturer-defined). Additionally, this network variable will also be transmitted as a heartbeat output on a regular basis as specified by the Maximum Send Time `<nciSndHrtBt>` configuration property.

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is acknowledged.

Effective Operating Mode

```
network output SNVT_hvac_mode nvoEffOpMode;
```

This output network variable provides the actual pump operating mode. The value of this network variable is the same as the value of the Requested Operating Mode (nviPumpOpMode) except when HVAC_AUTO is requested by the network variable and a different mode is selected by a locally wired input.

Valid Range

0	**HVAC_AUTO**	**Normal operation**	**<nviPumpSetpoint> defines the effective setpoint**
1	HVAC_HEAT	not supported	
2	**HVAC_MRNG_WRMUP**	**Morning warmup**	**maximum capacity mode (Manufacturer defined)**
3	HVAC_COOL	not supported	
4	HVAC_NIGHT_PURGE	not supported	
5	**HVAC_PRE_COOL**	**Morning cooldown**	**maximum capacity mode (Manufacturer defined)**
6	**HVAC_OFF**	**Offline Mode**	**override mode (Manufacturer defined)**
7	**HVAC_TEST**	**Equipment being tested**	**(Manufacturer defined)**
8	HVAC_EMERG_HEAT	not supported	
9	HVAC_FAN_ONLY	not supported	
10	HVAC_FREE_COOL	not supported	
11	HVAC_ICE	not supported	
12	HVAC_MAX_HEAT	not supported	
13	**HVAC_ECONOMY**	**Energy saving**	**minimum capacity mode (Manufacturer defined)**
0xFF	**HVAC_NUL**	**Invalid value**	

When Transmitted

This value is transmitted immediately when its value has changed. Additionally, this network variable will also be transmitted as a heartbeat output on a regular basis as specified by the Maximum Send Time <nciSndHrtBt> configuration property.

Update Rate

This value will be updated no faster than the Minimum Send Time <nciMinOutTm> configuration property value, if used (manufacturer-defined).

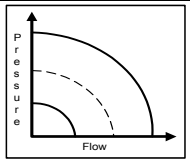
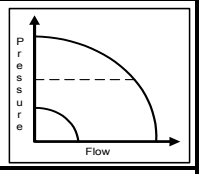
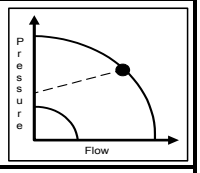
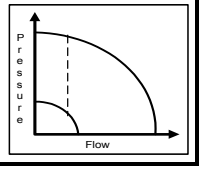
Default Service Type

The default service type is acknowledged.

Effective Device Control Mode

```
network output SNVT_dev_c_mode nvoControlMode;
```

This output network variable provides the actual control mode of the pump.

Control Mode	Description	
0 = SPEED_CONST	The setpoint of the pump will be interpreted as setpoint for the pump speed.	
1 = PRESS_CONST	The setpoint of the pump will be interpreted as setpoint for the pump pressure. The controller inside the pump will change the pump speed so that the pressure is constant. The controlled pressure can be the pump pressure or can come from an external pressure sensor.	
2 = PRESS_COMP	The setpoint of the pump will be interpreted as setpoint for the pressure.	
3 = FLOW_CONST	The setpoint of the pump will be interpreted as setpoint for the pump flow. The controller inside the pump will change the pump speed so that the flow will be constant. The controlled flow can be the flow through the pump or the flow signal can come from an external sensor.	

Valid Range

0	SPEED_CONST	Pump is running in the constant speed mode
1	PRESS_CONST	Pump is running in the constant pressure mode
2	PRESS_COMP	Pump is running in the compensated pressure mode
3	FLOW_CONST	Pump is running in the constant flow mode
5	TEMP_CONST	Pump is running in the constant temperatur mode

When Transmitted

This value is transmitted immediately when its value has changed. Additionally, this network variable will also be transmitted as a heartbeat output on a regular basis as specified by the Maximum Send Time `<nciSndHrtBt>` configuration property.

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is acknowledged.

Optional Network Variables

Pump Override Stop Command

```
network input SNVT_switch nviPumpOvdStop;
```

This input network variable provides a manual override function to stop the pump, typically from a supervisory device. The value "OVDSTOP" stops the pump and has priority over the value of the Pump Setpoint <nviPumpSetpoint> and the three override setpoints <nviOvdSpeed>, <nviOvdPress> and <nviOvdFlow>.

The manual override status of the pump controller is indicated in the output network variable <nvoPumpOverride>.

Valid Range

State	Value	Equivalent Percent	Requested Operation
0	n/a	n/a	NORMAL
1	0	n/a	NORMAL
1	1 to 255	n/a	OVDSTOP
0xFF	n/a	n/a	invalid (NORMAL)

Default value

Default value is 0xFF (invalid value) in the state field. The value will be adopted at power-up.

Override Setpoint for Speed

```
network input SNVT_lev_percent nviOvdSpeed;
```

This input network variable provides an override request and a speed setpoint, typically from a supervisory device. This speed setpoint is given as a percentage of the maximum speed of the pump. When a valid value is received and the Pump Override Stop Command is not active, the current pump setpoint (<nviPumpSetpoint> or <nviOvdPress> or <nviOvdFlow>) will be overridden and the pump will be controlled to the given speed setpoint.

Invalid values of all three override setpoint inputs <nviOvdSpeed>, <nviOvdPress>, <nviOvdFlow> and a normal status of the Pump Override Stop Command <nviPumpOvdStop> will set the pump back into the normal mode. The manual override status of the pump controller is indicated in the output network variable <nvoPumpOverride>.

Valid Range

-163.84% .. 163.83% (0.005% or 50 ppm). The value 0x7FFF represents invalid data that must be interpreted as "no override requested".

The override setpoint will be limited by the manufacturer defined setpoint limits and affected by the user defined operational limits.

Default value

Default value is 0x7FFF (invalid value). The value will be adopted at power-up.

Override Setpoint for Pressure

```
network input SNVT_press nviOvdPress;
```

This input network variable provides an override request and a pressure setpoint, typically from a supervisory device. When a valid value is received and the Pump Override Stop Command is not active, the current pump setpoint (<nviPumpSetpoint> or <nviOvdSpeed> or <nviOvdFlow>) will be overridden and the pump will be controlled to the given pressure setpoint. The pump works then in the PRESS_CONST mode.

Invalid values of all three override setpoint inputs <nviOvdSpeed>, <nviOvdPress>, <nviOvdFlow> and a normal status of the Pump Override Stop Command <nviPumpOvdStop> will set the pump back into the normal mode. The manual override status of the pump controller is indicated in the output network variable <nvoPumpOverride>.

Valid Range

-3,276.8 .. 3,276.7 kiloPascals (0.1 kPa). The value 0x7FFF represents invalid data that must be interpreted as ”no override requested”.

The override setpoint will be limited by the manufacturer defined setpoint limits and affected by the user defined operational limits.

Default value

Default value is 0x7FFF (invalid value). The value will be adopted at power-up.

Override Setpoint for Flow

```
network input SNVT_flow_p nviOvdFlow;
```

This input network variable provides an override request and a flow setpoint, typically from a supervisory device. When a valid value is received and the Pump Override Stop Command is not active, the current pump setpoint (<nviPumpSetpoint> or <nviOvdSpeed> or <nviOvdPress>) will be overridden and the pump will be controlled to the given flow setpoint.

Invalid values of all three override setpoint inputs <nviOvdSpeed>, <nviOvdPress>, <nviOvdFlow> and a normal status of the Pump Override Stop Command <nviPumpOvdStop> will set the pump back into the normal mode. The manual override status of the pump controller is indicated in the output network variable <nvoPumpOverride>.

Valid Range

0 .. 655,34 m^3/h (0,01). The value 0xFFFF represents invalid data that must be interpreted as ”no override requested”.

The override setpoint will be limited by the manufacturer defined setpoint limits and affected by the user defined operational limits.

Default value

Default value is 0xFFFF (invalid value). The value will be adopted at power-up.

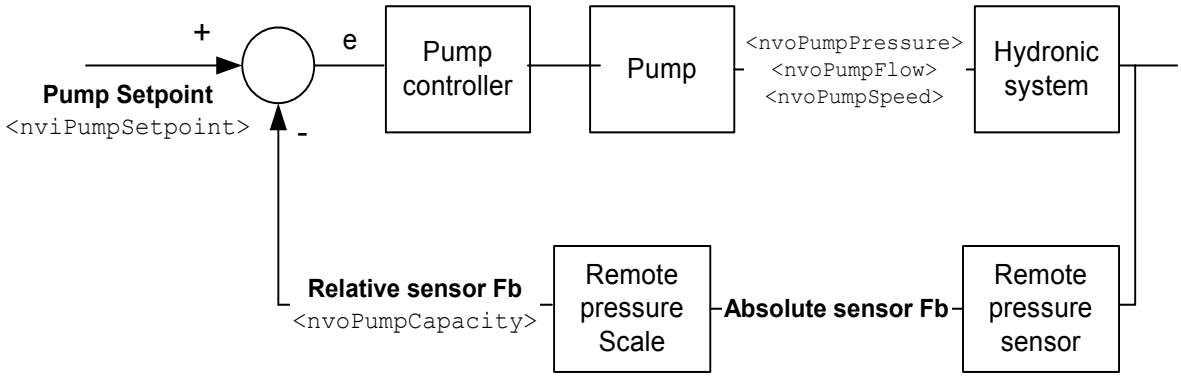
Remote Pressure Sensor Input

```
network input SNVT_press nviRemotePress;
```

The network variable <nviRemotePress> allows the use of a remote differential pressure sensor on the network as the feedback signal to the pump controller. A valid value on the network variable <nviRemotePress> will disable the internal feedback signal of the pump controller and activate the remote sensor operating mode, forcing the pump to run in the constant pressure control mode. This is indicated by a Bit12 in <nvoPumpStatus>. The output variable <nvoPumpCapacity> will indicate the value of the pressure signal from the sensor as a percentage of its maximum value. This makes it possible to compare the sensor value with the <nviPumpSetpoint> value. The output variable <nvoPressure> will always indicates the differential pressure across the pump flanges measured or estimated by the pump controller. This may help in analyzing the behavior of the system. When using <nviRemotePress>, the pressure setpoint is given by <nviPumpSetpoint>. The ranging of both the setpoint and the feedback is given by the configuration property Remote Pressure Sensor Range <nciRemPressRange>. The configuration property gives a minimum and a maximum value, and these values are used in place of the Manufacturer defined Setpoint Limits <nroManufSetLim> values.

If the variable <nviRemotePress> receives an invalid value or the heartbeat is missing, remote control is de-activated, and the pump controller will return to the control mode defined in <nciControlMode>.

The manual override inputs will take priority over the remote sensor control, and the pump controller will use the internal feedback signals.



Valid Range

-3,276.8 .. 3,276.7 kilo Pascal (0.1 kPa). The value 0x7FFF represents invalid data and can be interpreted as ”not connected”.

Default value

Default value is 0x7FFF (invalid value). The value will be adopted at power-up and in case of not receiving an update within the specified receive heartbeat time.

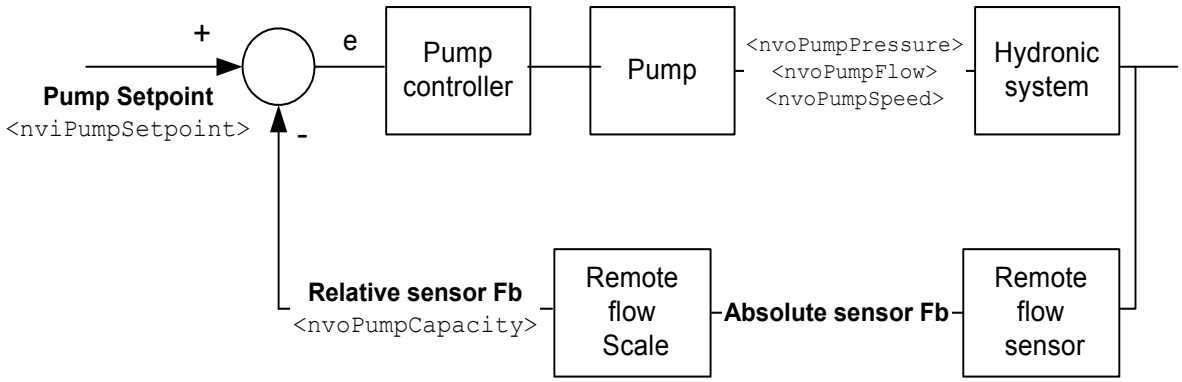
Remote Flow Sensor Input

```
network input SNVT_flow_p nviRemoteFlow;
```

The network variable <nviRemoteFlow> allows the use of a remote flow sensor on the network as the feedback signal to the pump controller. A valid value on the network variable <nviRemoteFlow> will disable the internal feedback signal of the pump controller and activate the remote sensor operating mode, forcing the pump to run in the constant flow control mode. This is indicated by a Bit13 in <nvoPumpStatus>. The output variable <nvoPumpCapacity> will indicate the value of the flow signal from the sensor as a percentage of its maximum value. This makes it possible to compare the sensor value with the <nviPumpSetpoint> value. The output variable <nvoFlow> will always indicates the flow between the pump flanges measured or estimated by the pump controller. This may help in analyzing the behavior of the system. When using <nviRemoteFlow>, the flow setpoint is given by <nviPumpSetpoint>. The ranging of both the setpoint and the feedback is given by the configuration property Remote Flow Sensor Range <nciRemFlowRange>. The configuration property gives a minimum and a maximum value, and these values are used in place of the Manufacturer defined Setpoint Limits <nroManufSetLim> values.

If the variable <nviRemoteFlow> receives an invalid value or the heartbeat is missing, remote control is de-activated, and the pump controller will return to the control mode defined in <nciControlMode>.

The manual override inputs will take priority over the remote sensor control, and the pump controller will use the internal feedback signals.



.

Valid Range

0 .. 655.34 m³/h (0.01 m³/h). The value 0xFFFF represents invalid dataand can be interpreted as ”not connected”.

Default value

Default value is 0xFFFF (invalid value). The value will be adopted at power-up and in case of not receiving an update within the specified receive heartbeat time.

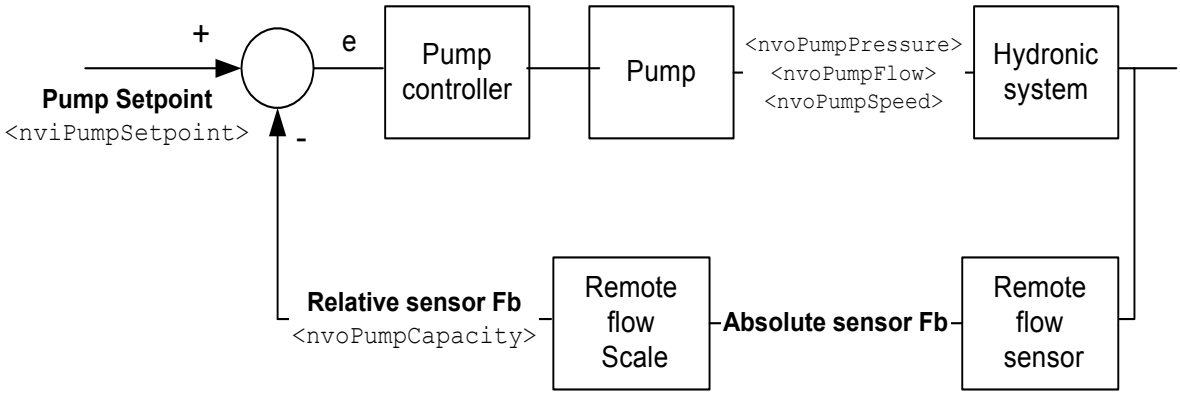
Remote Temperature Sensor Input

```
network input SNVT_temp_p nviRemoteTemp;
```

The network variable <nviRemoteTemp> allows the use of a remote temperature sensor on the network as the feedback signal to the pump controller. A valid value on the network variable <nviRemoteTemp> will disable the internal feedback signal of the pump controller and activate the remote sensor operating mode, forcing the pump to run in the constant temperature control mode. This is indicated by a Bit14 in <nvoPumpStatus>. The output variable <nvoPumpCapacity> will indicate the value of the temperature signal from the sensor as a percentage of its maximum value. This makes it possible to compare the sensor value with the <nviPumpSetpoint> value. When using <nviRemoteTemp>, the temperature setpoint is given by <nviPumpSetpoint>. The ranging of both the setpoint and the feedback is given by the configuration property Remote Temperature Sensor Range <nciRemTempRange>. The configuration property gives a minimum and a maximum value, and these values are used in place of the Manufacturer defined Setpoint Limits <nroManufSetLim> values.

If the variable <nviRemoteTemp> receives an invalid value or the heartbeat is missing, remote control is de-activated, and the pump controller will return to the control mode defined in <nciControlMode>.

The manual override inputs will take priority over the remote sensor control, and the pump controller will use the internal feedback signals.



.

Valid Range

-273.17 .. +327.66 degrees C (0.01 degree C). The value 0xFFFF represents invalid data and can be interpreted as ”not connected”.

Default value

Default value is 0xFFFF (invalid value). The value will be adopted at power-up and in case of not receiving an update within the specified receive heartbeat time.

Pump Status Diagnostic Information

```
network output SNVT_state nvoPumpStatus;
```

This output network variable provides detailed diagnostic information on the status of the pump controller.

Valid Range

The individual bits of the network variable are used as follows:

Bit0 = Pump controller fault *(see nvoPumpFault for detailed information)*
Bit1 = Supply fault *(no electrical power, no fluid in pump, etc. - see nvoPumpFault for detailed information)*
Bit2 = future use
Bit3 = Pump is controlled at low limit *(the pump is running at the lowest possible speed, therefore the requested performance is not possible)*
Bit4 = Pump is controlled at high limit *(the pump is running at the highest possible speed, therefore the requested performance is not possible)*
Bit5 = future use
Bit6 = Setpoint is out of range
Bit7 = future use
Bit8 = Pump is locally controlled *(hardware override)*
Bit9 = future use
Bit10 = Pump is running
Bit11 = future use
Bit12 = Pump controller using remote pressure sensor
Bit13 = Pump controller using remote flow sensor
Bit14 = Pump controller using remote temperature sensor
Bit15 = future use

When Transmitted

This value is transmitted immediately when its state has changed . Additionally, this network variable will also be transmitted as a heartbeat output on a regular basis as specified by the Maximum Send Time `<nciSndHrtBt>` configuration property.

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is acknowledged.

Pump Pressure

```
network output SNVT_press nvoPressure;
```

This optional output network variable provides the pressure between the pump flanges as estimated or measured by the pump controller.

Valid Range

-3,276.8 .. 3,276.7 kilo Pascal (0.1 kPa). The value 0x7FFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer).

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Pump Flow

```
network output SNVT_flow_p nvoFlow;
```

This optional output network variable provides the flow through the pump as estimated or measured by the pump controller.

Valid Range

0 .. 655,34 m^3/h (0,01 m^3/h). The value 0xFFFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer).

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Pump Speed

```
network output SNVT_rpm nvoSpeed;
```

This optional output network variable provides the speed of the pump.

Valid Range

0 .. 65,534 revolutions/minute (1 RPM). The value 0xFFFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer).

Update Rate

This value will be updated no faster than the Minimum Send Time <nciMinOutTm> configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Pump Override Active

```
network output SNVT_switch nvoPumpOverride
```

This optional output network variable provides the manual override status of the pump.

Valid Range

State	Value	Equivalent Percent	Override Status
0	0	n/a	Normal
0	1	n/a	not allowed
1	0	n/a	not allowed
1	1	n/a	OVERRIDE
0xFF	n/a	n/a	invalid value

When Transmitted

This value is transmitted immediately when its value has changed..

Update Rate

This value will be updated no faster than the Minimum Send Time <nciMinOutTm> configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Runtime

```
network output SNVT_time_hour nvoRuntime;
```

This output network variable provides the total running time for the pump in hours. After 65535 hours the counter starts again at zero.

Valid Range

The valid range is 0 .. 65535 hours (1 hour), (2730 days or 7.67 years).

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer)..

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Fault States of the Pump

```
network output SNVT_state nvoPumpFault;
```

This output network variable provides fault information of the pump. The fault can be device fault or can be supply fault. The network configuration property <nroFaultMask> defines which fault states will be supported.

Valid Range

The individual bits of the network variable are used as follows:

Bit0 = Supply fault, supply voltage too low
Bit1 = Supply fault, supply voltage too high
Bit2 = Supply fault, power missing phase
Bit3 = Supply fault, no fluid in pump
Bit4 = Supply fault, system pressure too low
Bit5 = Supply fault, system pressure too high
Bit6 = Supply fault, future use
Bit7 = Supply fault, future use
Bit8 = Device fault, motor high temperature
Bit9 = Device fault, motor fatal failure
Bit10 = Device fault, pump blocked
Bit11 = Device fault, electronic high temperature
Bit12 = Device fault, electronic non fatal failure
Bit13 = Device fault, electronic fatal failure
Bit14 = Device fault, sensor failure
Bit15 = Device fault, future use

When Transmitted

This value is transmitted immediately when one of the states has changed.

Update Rate

This value will be updated no faster than the Minimum Send Time <nciMinOutTm> configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Maintenance States

```
network output SNVT_state nvoMaintenance;
```

This output network variable provides the maintenance information of the pump. The network configuration property <nroMaintMask> defines which maintenance states will be supported.

Valid Range

The individual bits of the network variable are used as follows:

Bit0 = Service required
Bit1 = Change bearings
Bit2 = Grease bearings
Bit3 = Change shaft seal
Bit4 = Low/reduced performance
Bit5 = future use
Bit6 = future use
Bit7 = future use
Bit8 = future use
Bit9 = future use
Bit10 = future use
Bit11 = future use
Bit12 = future use
Bit13 = future use
Bit14 = future use
Bit15 = future use

When Transmitted

This value is transmitted immediately when one of the states has changed.

Update Rate

This value will be updated no faster than the Minimum Send Time <nciMinOutTm> configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Fluid Temperature

```
network output SNVT_temp_p nvoFluidTemp;
```

This optional output network variable provides the temperature of the fluid in the pump.

Valid Range

-273.17 .. +327.66 degrees C (0.01 degrees C). The value 0x7FFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer)..

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Power Consumption in Watts

```
network output SNVT_power nvoPower;
```

This optional output network variable provides the actual power being consumed by the pump. This output is suitable for pumps up to 6 kW.

Valid Range

0 .. 6,553.5 Watts (0.1 W). The value 0x7FFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer)..

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Power Consumption in KiloWatts

```
network output SNVT_power_kilo nvoPowerKilo;
```

This optional output network variable provides the actual power being consumed by the pump. This output is suitable for pumps larger than 6 kW.

Valid Range

0 .. 6,553.5 kW (0.1 kW). The value 0x7FFF represents invalid data.

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer)..

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Energy Consumption

```
network output SNVT_elec_kwh nvoEnergyConsum;
```

This optional output network variable provides the Energy Consumption of the pump from the beginning of its life. After 65,535 kWh the counter resets to 0 kWh.

Valid Range

0 .. 65,535 kilo Watt hour (1 kWh).

When Transmitted

This value is transmitted immediately when its value has changed significantly (as defined by the manufacturer)..

Update Rate

This value will be updated no faster than the Minimum Send Time `<nciMinOutTm>` configuration property value, if used (manufacturer-defined).

Default Service Type

The default service type is unacknowledged.

Mandatory Configuration Properties

Send Heartbeat

```
network input config SNVT_time_sec nciSndHrtBt;
```

This configuration property defines the maximum period of time that expires before the specified network variable outputs will automatically be updated. The specific method for sending heartbeat updates is manufacturer-defined.

Network variable outputs can be defined in 2 categories for the use of send heartbeat, based upon whether they are specified for send heartbeat in the Network Variable Output Table, as shown below:

Network Variable Output	Specified for Send Heartbeat in Table?	Result: Use Send Heartbeat?
Category 1	Yes	Yes
Category 2	No	Manufacturer-defined

Valid Range

The valid range is 0.0 to 6,553.4 sec (0.1 sec)

The valid range is = 0 disables the Send Heartbeat mechanism.

Typical Default Value

0 (no automatic update)

SCPT Reference

SCPTmaxSendTime (49)

Manufacturer defined Setpoint Limits

`network output config nroManufSetLim;`

This output configuration property provides a structure of limits for the various pump control modes. These limits provide a reference for the `<nviPumpSetpoint>` relative input when a remote pressure or flow sensor is not used.

Valid Range

The valid range of the manufacturer defined Setpoint Limits is determined by the structure:

```
typedef struct {
   SNVT_press          PressConstMin
   SNVT_press          PressConstMax
   SNVT_press          PressCompMin
   SNVT_press          PressCompMax
   SNVT_rpm            SpeedMin
   SNVT_rpm            SpeedMax
   SNVT_flow_p         FlowConstMin
   SNVT_flow_p         FlowConstMax
...SNVT_temp_p         TempConstMin
   SNVT_temp_p         TempConstMax

} SCPT_ManufSetLim
```

Default Value

The configuration property `<nroManufSetLim>` is read only. These limits will be set by the manufacturer only.

SCPT Reference

SCPT_ManufSetLim (#new number needed).

Pump Fault States Mask

```
network output config SNVT_state nroFaultMask;
```

This output configuration property provides the fault states that are supported by the pump controller. If the optional network variable <nvoPumpFault> is not implemented, then all bits of this mask must be set to FALSE.

Valid Range

The individual bits of the network variable are used as follows:

Bit0 = Supply fault, supply voltage too low
Bit1 = Supply fault, supply voltage too high
Bit2 = Supply fault, power missing phase
Bit3 = Supply fault, no fluid in pump
Bit4 = Supply fault, system pressure too low
Bit5 = Supply fault, system pressure too high
Bit6 = Supply fault, future use
Bit7 = Supply fault, future use
Bit8 = Device fault, motor high temperature
Bit9 = Device fault, motor fatal failure
Bit10 = Device fault, pump blocked
Bit11 = Device fault, electronic high temperature
Bit12 = Device fault, electronic non fatal failure
Bit13 = Device fault, electronic fatal failure
Bit14 = Device fault, sensor failure
Bit15 = Device fault, future use

Default Value

The configuration property <nroFaultMask> is read only. The supported fault states will be set by the manufacturer only.

SCPT Reference

SCPTFaultMask (#new number needed).

Maintenance States Mask

```
network output config SNVT_state nroMaintMask;
```

This output configuration property provides the maintenance states supported by the pump controller. If the optional network variable <nvoMaintenance> is not implemented, then all bits of this mask must be set to FALSE.

Valid Range

The individual bits of the network variable are used as follows:

Bit0 = Service required
Bit1 = Change bearings
Bit2 = Grease bearings
Bit3 = Change shaft seal
Bit4 = Low/reduced performance
Bit5 = future use
Bit6 = future use
Bit7 = future use
Bit8 = future use
Bit9 = future use
Bit10 = future use
Bit11 = future use
Bit12 = future use
Bit13 = future use
Bit14 = future use
Bit15 = future use

Default Value

The configuration property <nroMainMask> is read only. The supported maintenance states will be set by the manufacturer only.

SCPT Reference

SCPTMaintMask (#new number needed).

Pump Characteristic

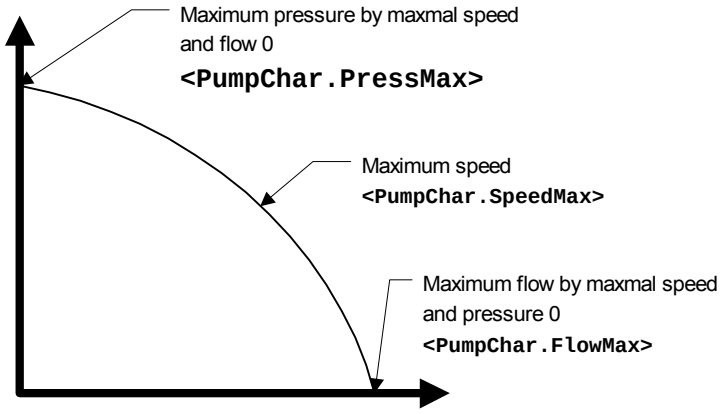
```
network output config nroPumpChar;
```

This output configuration property provides the basic characteristic data for the pump. For further technical information refer to the manufacturer documentation.

Valid Range

The valid range of the supported pump characteristics are given in the following structure:

```
typedef struct {
   SNVT_rpm             SpeedMax
   SNVT_press           PressMax
   SNVT_flow_p          FlowMax
} SCPT_PumpChar
```



Default Value

The configuration property `<nroPumpChar>` is read only. The Pump Characteristic will be set by the manufacturer only.

SCPT Reference

SCPTPumpChar (#new number needed).

Optional Configuration Properties

Location Label

```
network input config SNVT_str_asc  nciLocation;
```

This configuration property can optionally be used to provide more descriptive physical location information than can be provided by the Neuron Chip's 6 byte location string. The location relates to the object and not to the node.

Valid Range

Any NULL terminated ASCII string of 31 bytes total length.

Typical Default Value

The default value is an ASCII string containing all zeros ("\0").

SCPT Reference

SCPT_location (17)

Receive Heartbeat

```
network input config SNVT_time_sec nciRcvHrtBt;
```

This configuration property is used to control the maximum time that elapses after the last update of the network variables specified to in Table 2.1 before the Pump Controller Object starts to use its default values.

Valid Range

The valid range is 0.0 to 6,553.4 sec (0.1 sec)

The valid range is = 0 disables the Receive Heartbeat mechanism.

Typical Default Value

0 (no failure detect)

SCPT Reference

SCPTmaxRcvTime (48)

Minimum Send Time

```
network input config SNVT_time_sec nciMinOutTm;
```

This configuration property defines the minimum period of time between automatic network variable transmissions. Although this configuration property is optional, it must be provided if the minimum send time function is used.

Valid Range

0.0 to 6,553.4 sec (0.1 sec)
Setting `nciMinOutTm` = 0.0 disables transmission limiting.

Typical Default Value

0.5 sec

SCPT Reference

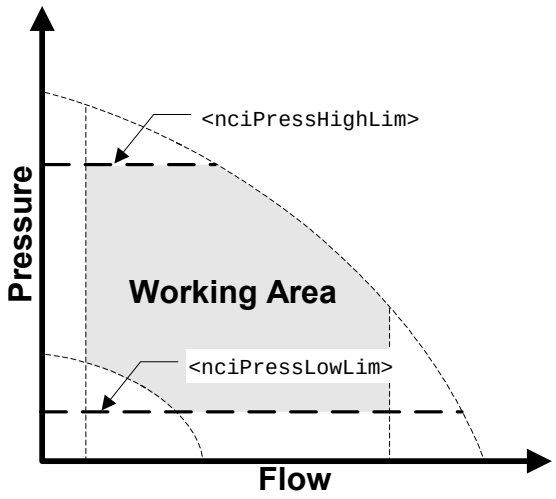
SCPTminSendTime (52)

User defined Operational Pressure Limits

`network input config SNVT_press nciPressLowLim;` and

`network input config SNVT_press nciPressHighLim;`

These configuration properties are used to define pressure limits for the working area of the pump. See following diagram:



Valid Range

The valid range of the pressure limits are:

```
<nroManufSetLim.PressConstMin>
                          <= <nciPressLowLim> <=
                               <nroManufSetLim.PressConstMax>

<nroManufSetLim.PressConstMin>
                          <= <nciPressHighLim> <=
                               <nroManufSetLim.PressConstMax>
```

Default Value

`<nciPressLowLim> = <nroManufSetLim.PressConstMin>`

`<nciPressHighLim> = <nroManufSetLim.PressConstMax>`

SCPT Reference

SCPTPressLowLim (#new number needed).

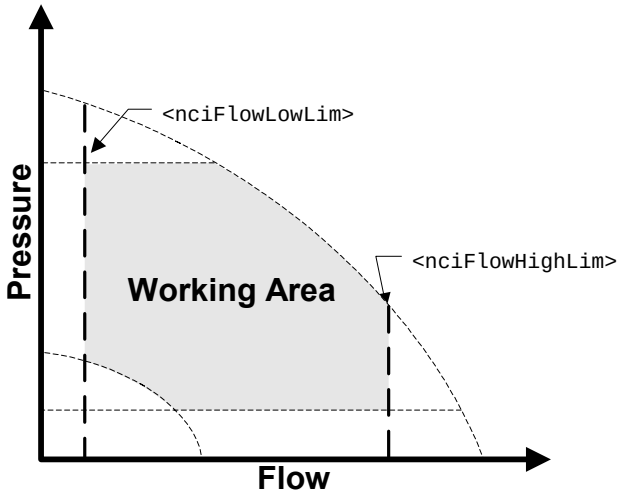
SCPTPressHighLim (#new number needed).

User defined Operational Flow Limits

`network input config SNVT_flow_p nciFlowLowLim;` and

`network input config SNVT_flow_p nciFlowHighLim;`

These configuration properties are used to define limits for the operating area of the pump as shown in the following diagram:



Valid Range

```
<nroManufSetLim.FlowConstMin>
                        <= <nciFlowLowLim> <=
                              <nroManufSetLim.FlowConstMax>

<nroManufSetLim.FlowConstMin>
                        <= <nciFlowHighLim> <=
                              <nroManufSetLim.FlowConstMax>
```

Default Value

`<nciFlowLowLim> = <nroManufSetLim.FlowConstMin>`

`<nciFlowHighLim> = <nroManufSetLim.FlowConstMax>`

SCPT Reference

SCPTflowLowLim (#new number needed).

SCPTflowHighLim (#new number needed).

Control Mode for Normal Operation

`network input config SNVT_dev_c_mode nciControlMode`

This configuration property defines the device control mode to be used for the normal operating mode when a remote network pressure or flow sensor is not bound to the controller and the internal speed, pressure or flow feedback signal is used by the controller.

Refer to Effective Device Control Mode (nvoEffControlMode) for details of the control modes.

Valid Range

0	SPEED_CONST	Pump will run in the constant speed mode
1	PRESS_CONST	Pump will run in the constant pressure mode
2	PRESS_COMP	Pump will run in the compensated pressure mode
3	FLOW_CONST	Pump will run in the constant flow mode
5	TEMP_CONST	Pump will run in the constant temperature mode

Typical Default Value

The default control mode for a pump is SPEED_CONST (value=0).

SCPT Reference

SCPTdevCntrlMode (#new number needed)

Remote Pressure Sensor Range

`network input config nciRemPressRange`

This input configuration property provides a structure of a minimum and maximum value for ranging the remote pressure sensor. These range values replace the manufacturer defined setpoint limits when the remote sensor is used (see Remote Pressure Sensor Input `nviRemotePress`).

Valid Range

The values of the pressure sensor range are given by:

```
typedef struct {
   SNVT_press          MinimumValue
   SNVT_press          MaximumValue
} SCPTpressRange
```

Default Value

```
<nciRemPressRange.MinimumValue> =
<nroManufSetLim.PressConstMin>
<nciRemPressRange.MaximumValue> =
<nroManufSetLim.PressConstMax>
```

SCPT Reference

SCPTpressRange (#new number needed).

Remote Flow Sensor Range

`network input config nciRemFlowRange`

This input configuration property provides a structure of a minimum and maximum value for ranging the remote flow sensor. These range values replace the manufacturer defined setpoint limits when the remote sensor is used (see Remote Flow Sensor Input `nviRemoteFlow`).

Valid Range

The values of the flow sensor range are given by:

```
typedef struct {
   SNVT_flow_p          MinimumValue
   SNVT_flow_p          MaximumValue
} SCPTflowRange
```

Default Value

```
<nciRemFlowRange.MinimumValue> = <nroManufSetLim.FlowConstMin>
<nciRemFlowRange.MaximumValue> = <nroManufSetLim.FlowConstMax>
```

SCPT Reference

SCPTflowRange (#new number needed).

Remote Temperature Sensor Range

`network input config nciRemTempRange`

This input configuration property provides a structure of a minimum and maximum value for ranging the remote temperature sensor. These range values replace the manufacturer defined setpoint limits when the remote sensor is used (see Remote Temperature Sensor Input `nviRemoteTemp`).

Valid Range

The values of the flow sensor range are given by:

```
typedef struct {
   SNVT_temp_p          MinimumValue
   SNVT_temp_p          MaximumValue
} SCPTtempRange
```

Default Value

```
<nciRemTempRange.MinimumValue> = <nroManufSetLim.TempConstMin>
<nciRemTempRange.MaximumValue> = <nroManufSetLim.TempConstMax>
```

SCPT Reference

SCPTtempRange (#new number needed).

Power-up State

The object will assume the default values and be ready to receive commands on its input network variables.

Boundary and Error Conditions

On a hardware failure, the pump device shall default to a pre-determined state (manufacturer defined). If possible, the device will continue to record errors.

Additional Considerations

The node object is to be used together with the Pump Controller Object and the following requests should be supported:

1. RQ_ENABLE = NO ACTION (AUTO); RQ_DISABLE = STOP. RQ_DISABLE shall always bring the pump to a controlled stop.

2. Status (SNVT_obj_status)

3. Reset fault (RQ_CLEAR_ALARM)

Proposed New SNVTs

The proposed SNVT´s and SCPT´s will be used in the proposed "Pump Controller Object" profile.
The proposed SNVT´s will be used in other profiles for HVAC applications.

1. We need the new SNVT_flow_p because teh existing SNVT´s does not have the right range and the right resolution which we need for the application.

2. To describe the different control modes of actuator type devices, there is not a SNVT which described the control function.

SNVT_flow_p

A network variable of type `SNVT_flow_p` to be used for heating, ventilation, and air conditioning applications. The typical flow in this area is 0.01 to 650 m^3/h.

Measurement

flow

Type Category

Fixed Point Scalar - unsigned long

Type Size

2 bytes

Valid Range (Resolution)

0 ... +655.34 m^3/h (0.01 m^3/h). The value 0xFFFF represents invalid data.

SNVT_dev_c_mode

A network variable of type `SNVT_dev_c_mode` to be used for heating, ventilation, and air conditioning applications. This network variable defines and indicates the control mode of devices like pumps, fans and other actuator based devices.

Measurement

Device control mode (in the first step only for a pump)

Type Category

Enumeration Scalar

Type Size

1 byte

Valid Range (Resolution)

Control_t Enumeration

Control_t Enumeration Type

Typedef File

`SNVT_DEV.H`

SNVT

SNVT_dev_c_mode

Enum Definitions

Value	*Identifier*	*Notes*
0	SPEED_CONST	Device (pump) runs in the constant speed mode
1	PRESS_CONST	Device (pump) runs in the constant pressure mode
2	PRESS_COMP	Device (pump) runs in the compensated pressure mode
3	FLOW_CONST	Device (pump) runs in the constant flow mode
4	FLOW_COMP	*For future use only*
5	TEMP_CONST	Device (pump) runs in the constant temperature mode
6	TEMP_COMP	*For future use only*

Proposed New SCPTs

The following proposed new SCPTs are used in this profile.

Configuration Property	Standard Configuration Property Type (SCPT)	Equivalent SNVT (SNVT Index)	SCPT Index
Manufacturer defined Setpoint Limits	SCPTmanufSetLim	N/A	TBD
Fault States Mask	SCPTfaultMask	SNVT_state	TBD
Maintenance States Mask	SCPTmaintMask	SNVT_state	TBD
Pump Characteristics	SCPTpumpChar	N/A	TBD
User-defined Pressure Low Limit	SCPTpressLowLim	SNVT_press	TBD
User-defined Pressure High Limit	SCPTpressHighLim	SNVT_press	TBD
User Flow Low Limit	SCPTflowLowLim	**SNVT_flow_p**	TBD
User Flow High Limit	SCPTflowHighLim	**SNVT_flow_p**	TBD
Control Mode for Normal Operation	SCPTdevCntrlMode	SNVT_dev_c_mode	TBD
Remote Pressure Sensor Ranging	SCPTpressRange	N/A	TBD
Remote Flow Sensor Ranging	SCPTflowRange	N/A	TBD
Remote Temperature Ranging	SCPTtempRange	N/A	TBD

Change History

Draft 0.5

1. **The first official draft for discussion only. This version replaced all version with a number lower then Draft 0.5.**
2. **At the moment the description for the scaling of external sensors are missing. Follows after the discussion with the pump experts on our next meeting on 27th of April.**

Draft 0.6

3. **Changed names of network variables to follow the proposals of the HVAC group.**

Draft 0.7

4. **Corrects the scale of pump setpoint.**
5. **Insert external fluid sensor model.**

Draft 0.9

6. **Corrects the text**
7. **Simplify the example usage section**
8. **Add `<nvoPumpOverride>`**
9. **Define `<nvoPumpStatus>` as optional**

Draft 0.92

10. **Add the temperature constant mode to the pump mode**