**Module types**

* [**Calculation level**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hcref.html)
* [**Heat structures**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hsref.html)
* [**Heat transfer**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/htref.html)
* [**HEAT\_CONNECTOR**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Heat_connector.html)
* [**HEAT\_TRANS**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Heat_trans.html)

|  |
| --- |
| 1 [**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#Introduction) |
| 2 [**Description of modules**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#Description_of_modules) |
| 2.1 [**HEAT\_STRUCTURE\_X**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#heat_struct_X) |
| 2.2 [**HEAT\_STRUCTURE\_XY**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#heat_struct_XY) |
| 2.3 [**HEAT\_CONNECTOR**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#heat_connector_local) |
| 2.4 [**HEAT\_STRANS**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#heat_trans_local) |
| 2.5 [**PARTICLE\_TRANSMITTER**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#particle_transmitter_local) |
| 3 [**Selecting a material**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html?cp=0_4_4#Selecting_a_material) |

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**1.** **Introduction**

It is usual in dynamic process modelling that besides the process taking place inside the tanks, pipe runs and equipment, also the structures used to construct the process system are needed to properly predict the system behavior. The common reason for this is heat transfer between fluids and structures. Accordingly, the structures are called as heat structures in Apros. It is important to consider the dimensions and the materials carefully in order to properly capture the thermal dynamics. There are several module types for describing the heat structures and transfer mechanisms. Many of them are automatically created in the calculation level, but some systems user builds up using process component level modules.

A typical example where heat structures are automatically created and used is HEAT\_PIPE, or any other heat exchangers. A common example where user graphically includes thermal system in the model, is HEAT\_STRUCTURE\_X.

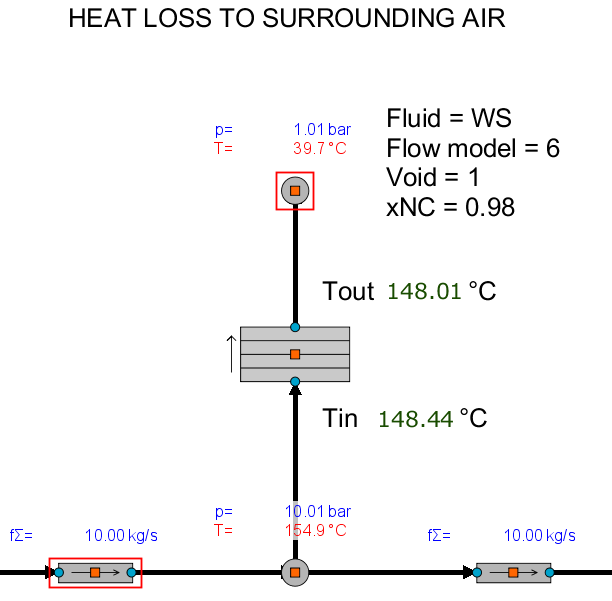
The process assembly may consist of several different materials (besides the default, stainless steel), so the user needs to select material from existing alternatives, and possibly needs to define new ones too. The following chapters describe heat transfer modules with examples and the selection procedure of the available materials in heat structures. The [**HSM\_MATERIAL**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html) reference gives the details for defining user's own heat structure materials.

**2.** **Description of modules**

The following section includes brief description of the modules and some typical heat transfer connections as an example.

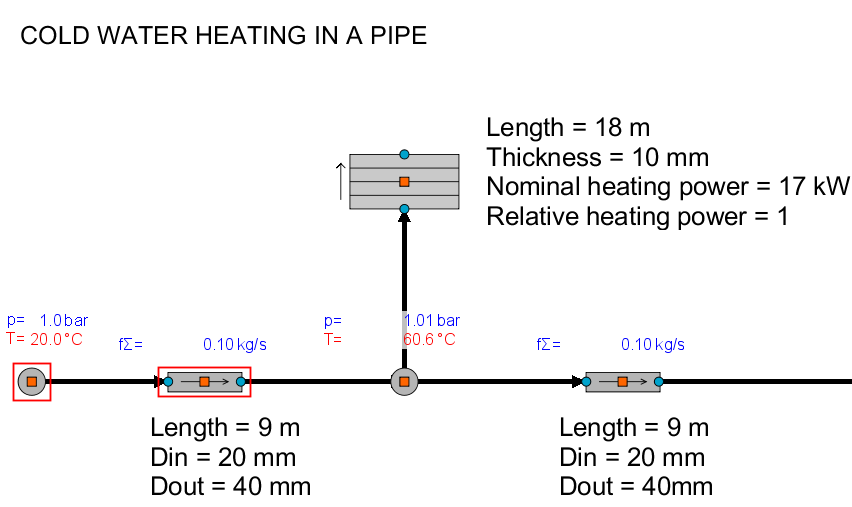
**2.1** **HEAT\_STRUCTURE\_X**

This module is used to calculate heat transfer between connected modules. It describes conduction in a layered structure, e.g. pipe wall, plate or spherical object (The HSX\_COORDINATE attribute determines shape). HSX\_CONNECT\_POINT\_1 is heat structure's inner surface and HSX\_CONNECT\_POINT\_2 is the outer surface. Typical connection when using one HEAT\_STRUCTURE\_X is between POINT module. In figure 1, the HEAT\_STRUCTURE\_X is used to describe heat loss to the surrounding air.



***Figure 1. Heat loss to the surrounding air can be estimated by using HEAT\_STRUCTURE\_X. Outer surface is connected to a POINT acting as boundary condition.***

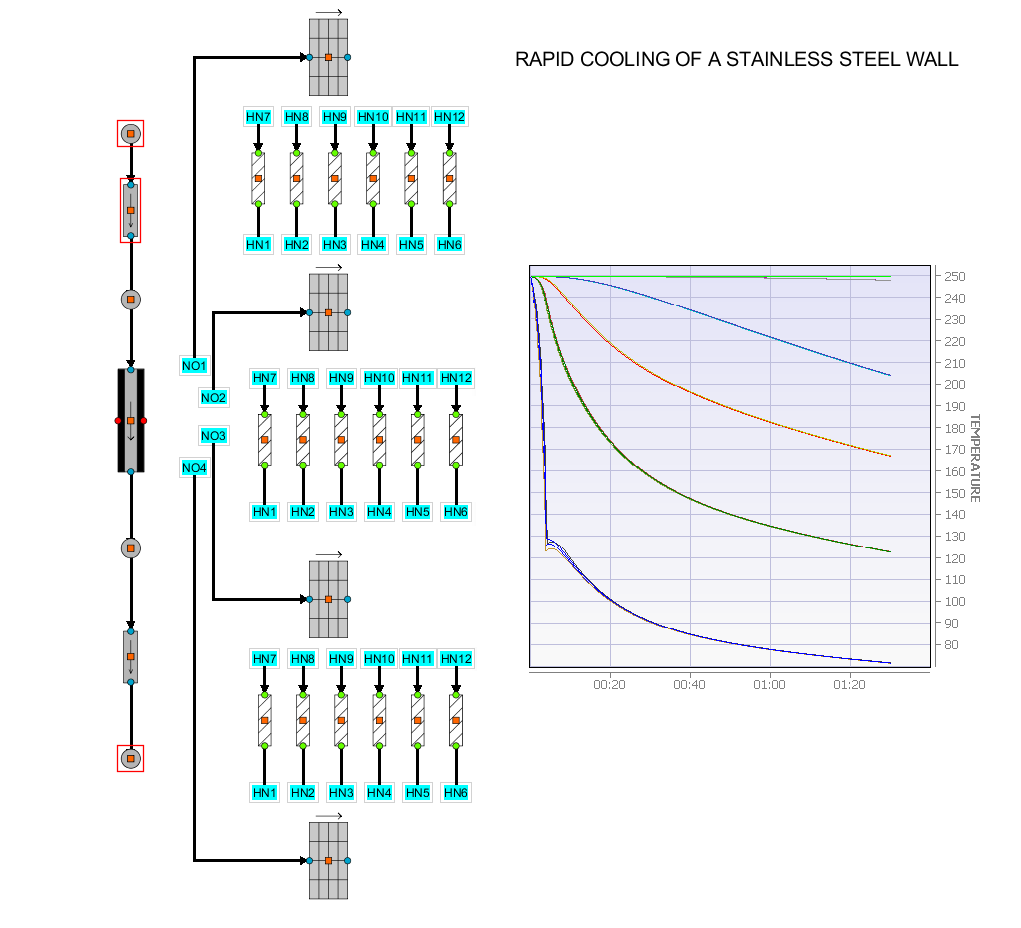
The next example illustrates cold water heating in a pipe. In both examples the pipe wall is described by HEAT\_STRUCTURE\_X. In figure 2, heat is generated inside the pipe wall and transferred to the flowing water.

  
***Figure 2. Water is heated from 20C to 60C in 18m long pipe by using HEAT\_STRUCTURE\_X component. Note that the outer surface is without connection.***

The heat flow (HSX\_HEAT\_FLOW\_1) in this example is negative, meaning that the heat flow is from the inner surface to the fluid. When looking at the symbol of HEAT\_STRUCTURE\_X the pointing arrow should be considered as "from inner surface to outer" rather than the direction of heat flow

**2.2** **HEAT\_STRUCTURE\_XY**

HEAT\_STRUCTURE\_XY is similar to HEAT\_STRUCTURE\_X. As the name implies, in addition having nodes in radial direction HEAT\_STRUCTURE\_XY can also create noding into axial direction. The connection points in HEAT\_STRUCTURE\_XY are also located in inner and outer surface of the structure. In order to create axial connection between other HEAT\_STRUCTURE\_XY, Axial heat structure branch (HSZ\_BRANCH) from calculation level should be used. Figure 3 contains an example of using multiple HEAT\_STRUCTURE\_XY connected in axial direction. This example simulates thermal shock i.e. rapid cooling of a plate wall.

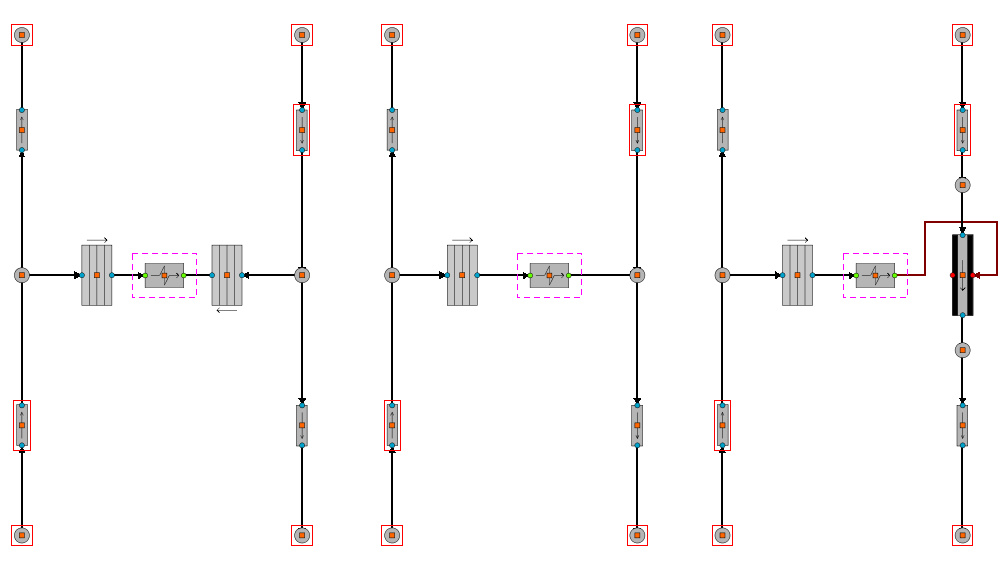


***Figure 3. Simplified model simulating rapid cooling of a stainless steel wall. Chart displays temperature distribution within the stainless steel. Lower temperatures in the chart are closer to the surface.***

In previous example, 2 m long HEAT\_PIPE has been divided into four nodes (NO1-NO4 in the figure) that are acting as input for HEAT\_STRUCTURE\_XY components. The stainless steel wall is described by four separate plate (HSXY\_COORDINATE = 1) HEAT\_STRUCTURE\_XY that have following dimensions: HSXY\_INSIDE\_RAD = 150 mm, HSXY\_BREADTH = 0.1 m, and HSXY\_LENGTH = 0.5 m. The rapid cooling takes place close to the surface, therefore HEAT\_STRUCTURE\_XY is divided in two layers, where the first layer (HSXY\_THICKNESS\_1) is 20 mm thick and second one (HSXY\_THICKNESS\_2) 130 mm, adding up to the 150 mm. First layer has four nodes in order to get better result and the second one contains two. Attribute HSXY\_HS\_NUMBER\_AXI determines the number of nodes in the axial direction. One should pay extra attention when creating axial connections since it is easy to make mistakes inadvertently. In this simplified example HSXY\_HS\_NUMBER\_AXI has the value 2, so total of 12 HS\_NODEs (HN1-HN12 in the figure) are created in every HEAT\_STRUCTURE\_XY.

**2.3** **HEAT\_CONNECTOR**

HEAT\_CONNECTOR is used to calculate heat transfer between two process components. HEAT\_CONNECTOR can be used between two HEAT\_STRUCTURE\_X, HEAT\_STRUCTURE\_X and POINT or HEAT\_STRUCTURE\_X and HEAT\_POINT. Connections are illustrated in Figure 4.



***Figure 4. Typical HEAT\_CONNECTOR connections between process components.***

Attribute HC\_CONNECTION\_TYPE defines the type of heat transfer used between two components. There are five possible variations of connection types: 1 = Heat conduction, 2 = Heat convection, 3 = Heat radiation, 4 = Heat convection and radiation, 5 = Combined heat transfer. When HEAT\_CONNECTOR is connected with a POINT, it is crucial to define heat transfer area and surface conditions.

When using heat radiation, the formula used for calculating heat transfer between two HEAT\_STRUCTURE\_X modules is

FF12 \* SBC \* (T1+T2) \* (T1\*T1+T2\*T2)

where

FF12 = 1/( (1/E1-1) + 1/F12 + A1/A2 \* (1/E2-1) )

SBC = Stefan-Boltzman Constant

E = Emissivity

F12 = view factor from surface 1 to surface 2

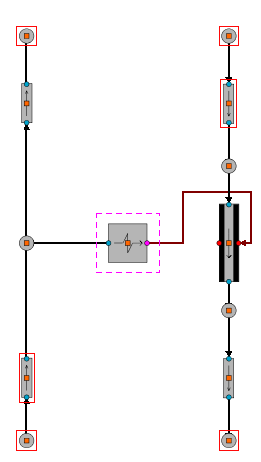
A = heat transfer Area

T = Temperature

|  |  |
| --- | --- |
| ***Table 1. Allowed HC\_CONNECTION\_TYPE values for different connections*** | |
| **Components connected by** **HEAT\_CONNECTOR** | **Allowed connection types** |
| HEAT\_STRUCTURE\_X HEAT\_STRUCTURE\_X | 1, 3, 4, 5 |
| HEAT\_STRUCTURE\_X POINT | 2, 3, 4 |
| HEAT\_STRUCTURE\_X HEAT\_POINT | 5 |

**2.4** **HEAT\_TRANS**

HEAT\_TRANS is used to calculate heat transfer between a heat structure and a connection point. Difference to the HEAT\_CONNECTOR is that HEAT\_TRANS is to be used without HEAT\_STRUCTURE\_X and HEAT\_TRANS module contains multiple heat transfer correlations to choose from. Figure 5 illustrates typical connection between POINT and HEAT\_POINT using HEAT\_TRANS component.

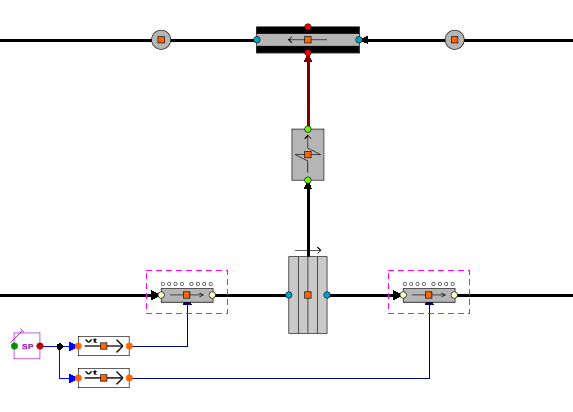


***Figure 5. HEAT\_TRANS between POINT and HEAT\_POINT.***

HEAT\_TRANS component contains multiple heat transfer correlations for user to choose from. HEAT\_GAS\_HT\_CORRELATION2 contains correlations for homogenous models and HEAT\_GAS\_HT\_CORRELATION contains correlations for 6-eq models.

**2.5** **PARTICLE\_TRANSMITTER**

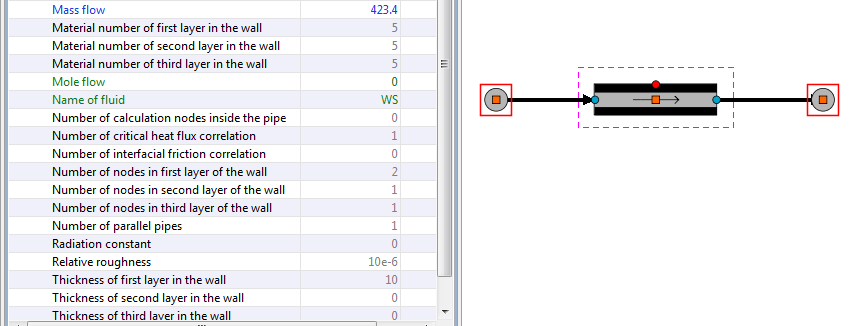
PARTICLE\_TRANSMITTER is used to transfer particles between heat structures. HEAT\_CONNECTOR should be used to estimate heat transfer between particles and a HEAT\_POINT.



***Figure 6. Typical connection in particle heat transfer consists of PARTICLE\_TRANSMITTER(s), HEAT\_STRUCTURE\_X, HEAT\_CONNECTOR and HEAT\_POINT.***

The mass flow in PARTICLE\_TRANSMITTER is updated either manually or by some automation component. When automation component is used, PAT\_CONTROL\_PROC\_COMP should be set 'true'. In the example above VALUE\_TRANSMITTER is used to determine particle mass flow. HEAT\_STRUCTURE\_X is set to describe the particles, i.e. spherical objects and HEAT\_CONNECTOR is used to allow heat transfer between HEAT\_POINT and the particles.

**3.** **Selecting a material**

The Apros database includes the most common heat structure materials. The material selection affects how heat is conducted from/to the fluid (or environment), and accumulated in the heat structure. The material is selected by a material number, as illustrated in Figure X for a HEAT\_PIPE module. Note that there are three layers available and for each of them a different material and nodalization can be given.  
***Figure 7. Material(s) of the piece of equipment is defined by a material number. The default material, number 5 corresponds to STAINLESS\_STEEL.***  
The materials have been defined with the HSM\_MATERIAL  modules. There are two easy ways to refer the materials and numbers:

* See [**Predefined materials**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html#Predefined_materials) table in the HSM\_MATERIALS reference
* Open Model Browser's Configuration, non-visual/Fluids and materials. For each material defined, the attribute HSM\_MAT\_NUMBER gives the number with which this material can be referred.

[**Heat structure and transfer**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/hstref.html)

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**BOUNDARY\_CONDITION**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\CAA637EF.tmp | Boundary Condition (Boundary condition) |

**Contents**

[**Boundary condition functions**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Boundary_condition_functions)  
[**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Introduction)  
[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Attributes)  
[**Linking of boundary condition modules**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Linking_of_boundary_condition_modules)  
[**Main Table of Contents**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/index.htm)

**Boundary condition functions**

The boundary condition functions are listed below. The list contains links to the documentations of these functions.

* [**No Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Nofunc.html)
* [**Sum Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Sum.html)
* [**Product Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Product.html)
* [**General Sum Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Sum2.html)
* [**General Product Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Product2.html)
* [**Sum of products**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Sumproduct.html)
* [**Average Value**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Average.html)
* [**Maximum Value**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Maximum.html)
* [**Minimum Value**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Minimum.html)
* [**Polynome Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Polynome.html)
* [**Power Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Power.html)
* [**Rational Function of Four Variables**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Rational.html)
* [**General Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/General.html)
* [**Table Function**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Table.html)
* [**Time Integral**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Integral.html)
* [**Boundary Condition Transfer**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boun_cond_transfer.html)

**Introduction**

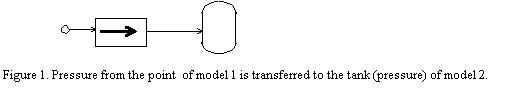
The module BOUNDARY\_CONDITION can be used to transfer values between database variables of APROS. The variable values are either transferred directly or the output values are calculated from a defined function. The module has several application possibilities. It can be used as a connection between two separate simulation models. In this case, the models calculate boundary conditions for each other. Time dependent boundary conditions are defined using an appropriate function. Output quantities can be defined to give information about the state of the simulated system. For example, sums or average values of calculation variables may be computed over a defined set of calculation modules. Integrals over a time period are also calculated. All boundary condition modules included in the simulation experiment are updated in the end of each simulation time step.

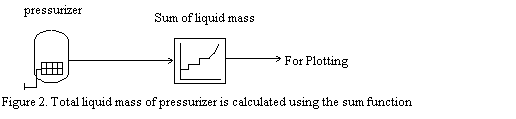
More complicated functions can be defined by using several boundary condition modules and linking them together.

The types of the input and output variables may be integer, real, double precision or logical (only when no function is performed).

The necessary input data for the boundary condition modules is as follows:

* name of the function to be performed
* names of the input module(s) and variable(s)
* names of the output module and variable
* constant coefficients of the function
* constant powers of the power function
* function number for the general function
* data points for the table function
* start and stop times for the time integral
* maximum and minimum values
* whether the boundary condition is simulated before or after external models

Figure 1 shows an example of a boundary condition module: the pressure of an internal point of some calculation model is transferred to an external tank of some other model (boundary condition for the pressure solution of the second model)

[**To contents of this component**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Contents)

**Attributes**

The boundary condition module needs as input data names of the input and output modules and variables and the name of the function to be performed. The output variable is not obligatory, because the value of the function is always stored into the attribute BC\_FUNC\_VALUE of the boundary condition module. Additional input data varies according to the function. Each defined function is introduced in the following chapter. The names MODULE1 and MO\_ATTRIBUTE are used in the examples to describe an arbitrary module in the database and an attribute belonging to the module. Attributes used for Boundary Conditions Module are displayed in table 1.

|  |  |
| --- | --- |
| *Table 1. Attribute, type, default value and descriptions* | |
| **ATTRIBUTE** **Property name** | **Description** |
| BC\_FUNCTION Name of performed function | defines the performed function. The name of the BC function is given to this attribute |
| BC\_INPUT\_MOD\_AND\_VAR\_n N:th input module and variable | is an object quartet defining the n:th input variable of the boundary condition module (an object quartet may consist of module name, attribute name, j-index and i-index or module name, variable name, j-index and i-index or variable name, n-index, j-index and i-index). n is between 1 and 4. |
| BC\_OUTPUT\_MOD\_AND\_VAR Output module and variable | is an object quartet defining the output variable of the boundary condition module (an object quartet may consist of module name, attribute name, j-index and i-index or module name, variable name, j-index and i-index or variable name, n-index, j-index and i-index). |
| BC\_INPUT\_MODULE\_n | obsolete |
| BC\_INPUT\_VARIABLE\_n | obsolete |
| BC\_INPUT\_VARIABLE\_n\_J | obsolete |
| BC\_INPUT\_VARIABLE\_n\_I | obsolete |
| BC\_OUTPUT\_MODULE | obsolete |
| BC\_OUTPUT\_VARIABLE | obsolete |
| BC\_OUTPUT\_VARIABLE\_J | obsolete |
| BC\_OUTPUT\_VARIABLE\_I | obsolete |
| BC\_COEF Constant coefficient of the product | defines the coefficient of a product function or a general product function. Default value is 1. |
| BC\_COEF\_n Coefficient of n:th product | defines the coefficient of the n:th input variable of a general sum function (n is between 1 and 4) or the n:th coefficient of a sum of products (n is between 1 and 2). Default value is 1 |
| BC\_POWER(n) Power to which input variable is raised | n is between 1 and 6. Defines the power for the n:th term of a power function. Default value is 0 |
| BC\_POWER\_n Power to which n:th input variable is raised | n is between 1 and 4. Defines the power to which the n:th input variable of a general sum function, a general product function or a sum of products is raised. Default value is 1 |
| BC\_COEFF(n) Coefficient of numerator | n is between 1 and 6. Defines the coefficients for a polynome, a power function, the numerator of a polynome or a general function. Default value is 0 |
| BC\_COEFF\_2(m) Coefficient of denominator | m is between 1 and 6. Defines the coefficients for the denominator of a rational function. Default value is 0 |
| BC\_FUNC\_NUMB(n) Number of performed function | n is between 1 and 6. Defines the function alternative as a subchoice of the general function |
| BC\_POINTS(n) Point defining the function | n is 1, 2 … 20. Defines a table of input/output point pairs for the table function. Input points are entered in increasing order. If less than 20 pairs are used, the last pair is defined by an extra point pair where the input is set at less than the last valid input value. |
| BC\_START\_TIME Start time of integration | defines the start time of integration for an integral function. The default value is 0 s. |
| BC\_STOP\_TIME End time of integration | defines the end time of integration for an integral function. The default value is 108 s. |
| BC\_CONSTANT Constant added to the value of the function | defines the constant value added to the value of the function. The default value is 0. |
| BC\_MAX\_GIVEN Is maximum value given | if this attribute has the value T (TRUE), the value of the attribute BC\_MAX\_VALUE is used. The default value is F (FALSE). |
| BC\_MAX\_VALUE Maximum value of transferred variable | defines the maximum value of the function. The maximum value is used only, if the attribute BC\_MAX\_GIVEN has the value T. The default value of the attribute is 0. |
| BC\_MIN\_GIVEN Is minimum value given | if this attribute has the value T (TRUE), the value of the attribute BC\_MIN\_VALUE is used. The default value is F (FALSE). |
| BC\_MIN\_VALUE Minimum value of transferred variable | defines the minimum value of the function. The minimum value is used only, if the attribute BC\_MIN\_GIVEN has the value T. The default value of the attribute is 0. |
| BC\_FUNC\_VALUE Value of transferred variable | contains the value of the function |
| BC\_SIM\_STAGE Simulation stage | defines whether the boundary condition is simulated before or after external models. Value 1 means before external models (this was the case in previous Apros versions). Value 2 means after the external models. The default value is 1. |

[**To contents of this component**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/boundref/Boundary_condition.html#Contents)

**Linking of boundary condition modules**

If some functions can not be represented by one boundary condition module, several modules may be linked together. This is done by defining the input module of a boundary condition module as the name of another boundary condition module. The input variable need not be given, because the value of the attribute BC\_FUNC\_VALUE is automatically used. Thus, one module calculates an intermediate result and stores it into the attribute BC\_FUNC\_VALUE. The second module then uses the result of the first module as its input variable. As many modules as necessary can be linked in this way. However, it isn't recommended to create closed loops. The calculation order is searched automatically when the boundary condition calculation is initialized.  
Figure 3 shows an example of the linking of boundary condition modules. The following function for temperature dependent heat losses is defined:

f = max[730 ­ 7300(0.273 + 0.001T)4, 0]

Furthermore, heat losses are only experienced on the outside surface of a heat structure. The attribute HSN\_TYPE has the value 5, if the heat structure node is on the outer surface of a heat structure and if no heat transfer modules are connected to the node. This attribute is utilized in the definition of heat losses. The following boundary condition modules (BC1, BC2, BC3 and BC4) are needed to perform the calculation:

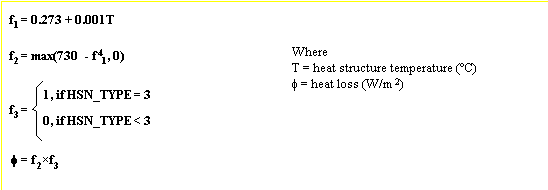
|  |  |
| --- | --- |
| *Table 2. BC1* | |
| **ATTRIBUTE** | **Value** |
| BC\_FUNCTION | POLYNOME |
| BC\_INPUT\_MOD\_AND\_VAR\_1 | EXP HSN\_TEMPERATURE |
| BC\_COEFF(1) | 0.273 |
| BC\_COEFF(2) | 0.001 |

|  |  |
| --- | --- |
| *Table 3. BC2* | |
| **ATTRIBUTE** | **Value** |
| BC\_FUNCTION | POLYNOME |
| BC\_INPUT\_MODULE\_1 | BC1 |
| BC\_COEFF(1) | 730 |
| BC\_COEFF(5) | 7300 |
| BC\_MAX\_GIVEN | T |
| BC\_MAX\_VALUE | 0 |

|  |  |
| --- | --- |
| *Table 4. BC3* | |
| **ATTRIBUTE** | **Value** |
| BC\_FUNCTION | TABLE |
| BC\_INPUT\_MOD\_AND\_VAR\_1 | EXP HSN\_TYPE |
| BC\_POINTS(1) | 1 0. |
| BC\_POINTS(2) | 4 0 |
| BC\_POINTS(3) | 5 1 |

|  |  |
| --- | --- |
| *Table 5. BC4* | |
| **ATTRIBUTE** | **Value** |
| BC\_FUNCTION | PRODUCT |
| BC\_INPUT\_MODULE\_1 | BC2 |
| BC\_INPUT\_MODULE\_2 | BC3 |
| BC\_OUTPUT\_MOD\_AND\_VAR | EXP HSN\_HEAT\_FLUX |

The heat losses are calculated in four steps. The modules BC1, BC2, BC3 and BC4 calculate the following functions:

*Figure 3. The heat loss calculation steps*

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**BOUN\_COND\_TRANSFER**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\2CC8DF27.tmp | Boundary Condition Transfer (Boundary condition transfer) |

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**Introduction**

The module type BOUN\_COND\_TRANSFER is used to transfer boundary conditions of the thermal hydraulic solution between two different APROS models or inside one model. The transferred variables are: pressure, enthalpy, void fraction, mass flow and concentrations.

The BOUN\_COND\_TRANSFER module is defined between two process components (e.g. pipes) or calculation level branches. The first pipe is in simulation and the second one out of simulation. If the boundary conditions are transferred between two different APROS models, the pipes and their connection points have to be defined in both models using exactly the same names. The boundary condition transfer module creates IO sets for transferring the boundary conditions.

See the [**Process and components guide**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/guides/procgui/procgui.htm#Boundary_Condition_Transfer) for an example of the use of boundary condition transfer.

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**Attributes**

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Attributes, types, default values and descriptions* | | | |
| **ATTRIBUTE** **Property name** | **Input/ Output** | **Default value** | **Description** |
| BCT\_BRANCH\_1 First branch | I | - | Name of the first pipe or branch connected to the module. The mass flow calculated by the first branch is transferred to the second branch. |
| BCT\_BRANCH\_2 Second branch | I | - | Name of the second pipe or branch connected to the module |
| BCT\_TRANSFER\_MODE Boundary condition transfer mode | I | 1 | Defines the boundary condition transfer mode. Possible values are   |  |  | | --- | --- | | 1 | (boundary conditions are transferred inside one simulation model, properties of the first branch and its inlet node are transferred to the second branch and its inlet node and properties of the outlet node of the second branch are transferred to the outlet node of the first branch), | | 2 | (properties of the first branch and its inlet node are transferred from the current simulation model to the second branch and its inlet node existing in another model) and | | 3 | (properties of the outlet node of the second branch are transferred from another model to the outlet node of the first branch in the current model) | |
| BCT\_IO\_FILE\_NAME IO file name | I | - | The file name for the created IO sets. This attribute has to be defined if boundary conditions are transferred between two APROS models. If the string "ACL: localhost Project1+Workspace1:8909" is given, the other APROS is running in the same computer (computer name localhost) with the project name Project1, workspace name Workspace1 and port number 8909. |
| BCT\_IO\_SET\_NAME Name of created IO set | O | - | Shows the names of the IO sets created by the module. They have to connected to the experiment (module EXPO) or activated with the command io open <name of IO set>. |

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**Boundary conditions of different thermal hydraulic**

The transferred boundary conditions are different according to the selected thermal hydraulic model. The boundary conditions are listed in this chapter.

**NODE variables**

The transferred boundary conditions of the node of the steady state model (module type NO0\_NODE) are:

* Pressure (attribute NO0\_PRESSURE)
* Enthalpy (NO0\_ENTHALPY)

The transferred boundary conditions of the node of the simplified homogeneous model (module type NO1\_NODE) are:

* Pressure (attribute NO1\_PRESSURE)
* Enthalpy (NO1\_MIX\_ENTH)

The transferred boundary conditions of the node of the homogeneous model (module type NO2\_NODE) are:

* Pressure (attribute NO2\_PRESSURE)
* Enthalpy (NO2\_MIX\_ENTH)
* Kinetic energy (NO2\_KINETIC\_ENERGY)
* Sum of momentum flows coming into the node (NO2\_MOM\_FLOW\_IN)
* Total area of branches whose flow is towards the node (NO2\_AREA\_IN)
* Total area of branches transferring momentum whose flow is towards the node (NO2\_MOM\_FLOW\_AREA\_IN)

The transferred boundary conditions of the node of the five-equation model (module type NO5\_NODE) are:

* Pressure (attribute NO5\_PRESSURE)
* Liquid enthalpy (NO5\_LIQ\_ENTH)
* Gas enthalpy (NO5\_GAS\_ENTH)
* Void fraction (NO5\_VOID)
* Volume fraction of noncondensable gas (NO5\_AIR\_FRACT)

The transferred boundary conditions of the node of the six-equation model (module type NO6\_NODE) are:

* Pressure (attribute NO6\_PRESSURE)
* Liquid enthalpy (NO6\_LIQ\_ENTH)
* Steam enthalpy (NO6\_STEAM\_ENTH)
* Void fraction (NO6\_VOID)
* Mass fraction of noncondensable gas in the gas phase (NO6\_NONC\_MASS\_FRAC)
* Mass fraction of dissolved noncondensable gas in the liquid phase (NO6\_DISS\_GAS\_MASS\_FRAC)
* Kinetic energy of liquid phase (NO6\_LIQ\_KINETIC\_ENERGY)
* Kinetic energy of gas phase (NO6\_GAS\_KINETIC\_ENERGY)
* Sum of liquid momentum flows coming into the node (NO6\_LIQ\_MOM\_FLOW\_IN)
* Sum of gas momentum flows coming into the node (NO6\_GAS\_MOM\_FLOW\_IN)
* Sum of liquid momentum flows going out of the node (NO6\_LIQ\_MOM\_FLOW\_OUT)
* Sum of gas momentum flows going out of the node (NO6\_LIQ\_MOM\_FLOW\_OUT)
* Stratification ratio (variable TNSTRA)
* Height of node (TNHEIC)

**BRANCH variables**

The transferred boundary condition of the branch of the steady state model (module type BR0\_BRANCH) is:

Mass flow (attribute BR0\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch of the simple homogeneous model (module type BR1\_BRANCH) is:

Mass flow (attribute BR1\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch of the homogeneous model (module type BR2\_BRANCH) is:

Mass flow (attribute BR2\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch of the five-equation model (module type BR5\_BRANCH) is:

Volume flow (attribute BR5\_MIX\_VOL\_FLOW)

The transferred boundary conditions of the branch of the six-equation model (module type BR6\_BRANCH) are:

* Liquid velocity (attribute BR6\_LIQ\_VELOC)
* Gas velocity (BR6\_GAS\_VELOC)

The transferred boundary condition of the branch between the simple homogeneous model and the steady state model (module type BR10\_BRANCH) is:

Mass flow (attribute BR10\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the simple homogeneous model and the homogeneous model (module type BR12\_BRANCH) is:

Mass flow (attribute BR12\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the simple homogeneous model and the five-equation model (module type BR15\_BRANCH) is:

Mass flow (attribute BR15\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the simple homogeneous model and the six-equation model (module type BR16\_BRANCH) is:

Mass flow (attribute BR16\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the homogeneous model and the steady state model (module type BR20\_BRANCH) is:

Mass flow (attribute BR20\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the homogeneous model and the five-equation model (module type BR25\_BRANCH) is:

Mass flow (attribute BR25\_MIX\_MASS\_FLOW)

The transferred boundary condition of the branch between the homogeneous model and the six-equation model (module type BR26\_BRANCH) is:

Mass flow (attribute BR26\_MIX\_MASS\_FLOW)

The transferred boundary conditions of the branch between the six-equation model and the five-equation model (module type BR65\_BRANCH) are:

* Liquid velocity (attribute BR65\_LIQ\_VELOC)
* Gas velocity (BR65\_GAS\_VELOC)

**Concentrations**

The transferred boundary conditions of the composition module type WSB\_COMPOSITION are:

* Concentrations of the liquid phase (attribute WSB\_LIQ\_CONCENTRATION)
* Concentration of the gas phase (WSB\_GAS\_CONCENTRATION)

The transferred boundary conditions of the composition module type WS20\_COMPOSITION are:

* Concentrations of the liquid phase (attribute WS20\_LIQ\_CONCENTRATION)
* Concentration of the gas phase (WS20\_GAS\_CONCENTRATION)
* Mixture concentrations (WS20\_CONCENTRATION)

The transferred boundary conditions of the composition module type WS50\_COMPOSITION are:

* Concentrations of the liquid phase (attribute WS50\_LIQ\_CONCENTRATION)
* Concentration of the gas phase (WS50\_GAS\_CONCENTRATION)
* Mixture concentrations (WS50\_CONCENTRATION)

The transferred boundary conditions of the composition module type WS200\_COMPOSITION are:

* Concentrations of the liquid phase (attribute WS200\_LIQ\_CONCENTRATION)
* Concentration of the gas phase (WS200\_GAS\_CONCENTRATION)
* Mixture concentrations (WS200\_CONCENTRATION)

The transferred boundary conditions of the composition module type WG\_COMPOSITION are:

Mixture concentrations (attribute WG\_CONCENTRATION)

The transferred boundary conditions of the composition module type FF\_COMPOSITION are:

Mixture concentrations (attribute FFCO\_CONCENTRATION)

The transferred boundary conditions of the composition module type FG\_COMPOSITION are:

Mixture concentrations (attribute FGCO\_CONCENTRATION)

The transferred boundary conditions of the composition module type QW\_COMPOSITION are:

Mixture concentrations (attribute QW\_CONCENTRATION)

The transferred boundary conditions of the composition module type EP\_COMPOSITION are:

Mixture concentrations (attribute EP\_CONCENTRATION)

The transferred boundary conditions of the composition module type PP\_COMPOSITION are:

Mixture concentrations (attribute PP\_CONCENTRATION)

The transferred boundary conditions of the composition module type PP20\_COMPOSITION are:

Mixture concentrations (attribute PP20\_CONCENTRATION)

The transferred boundary conditions of the composition module type PP50\_COMPOSITION are:

Mixture concentrations (attribute PP50\_CONCENTRATION)

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[**Special**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/auspe.html)  
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**BASIC\_VALVE**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| **C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\5A28791B.tmp** | Basic Valve |

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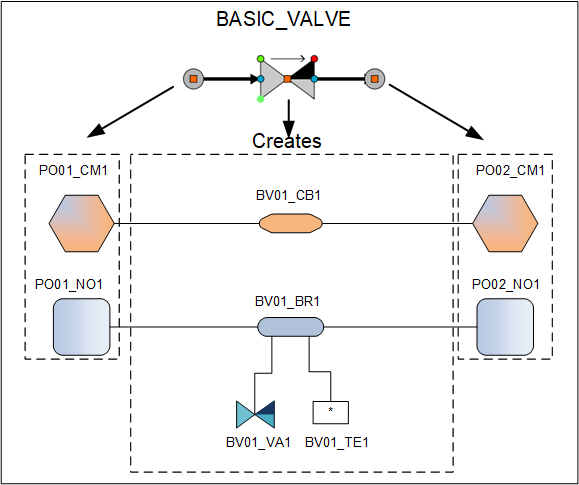
[**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Basic_valve.html#Introduction)  
[**Structure**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Basic_valve.html#Structure)  
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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
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**Introduction**

The BASIC\_VALVE module is a linear valve component. It is used to get the required liquid or gas flow through the valve by calculating the flow area of the valve as a function of the valve position. The user can open or close the valve by means of the attribute VA11\_POSITION. If desired, the system also creates the device controller for controlling the valve position and a heat structure representing the wall of the valve. A BASIC\_VALVE can be connected to the Flow models 0, 1 (one-phase model), 2 (homogeneous model), 4 (containment model), 5 (five-equation model) or 6 (six-equation model) and the Flow model of the valve is usually the same as the Flow model of the outlet connection point.

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**Structure**

*****Figure 1. Calculation level structure of a simple BASIC\_VALVE connection*

[**List of symbols**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Module_type_documentation_format.html#List_of_symbols)

Consider a BASIC\_VALVE connected to two points. The created structure is shown in Figure 1 and the relevant parameters for this kind of a calculation level structure are shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Relevant input parameters for a simple BASIC\_VALVE connection* | | | |
| **Attribute Property name** | **Unit** | **Value** | **Note** |
| VA11\_LENGTH Flow length of valve | m | 1 |  |
| VA11\_AREA\_GIVEN Is diameter or area given as input | - | 2 | The outside diameter and wall thickness are given as input parameters and the flow area is calculated from them |
| VA11\_OUTSIDE\_DIAM Outside diameter of valve | mm | 100 |  |
| VA11\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | 10 |  |
| VA11\_DRIVING\_TIME Driving time of valve | s | 1 |  |
| VA11\_LOSS\_COEFF Loss coefficient of fully open valve | - | 1 |  |
| VA11\_DISCHARGE\_COEFF Discharge coefficient | - | 0.75 |  |

BASIC\_VALVE creates two branches, one for thermal hydraulic calculation (BV01\_BR1) and the other for composition calculation (BV01\_CB1). Branches are connected to nodes of the inlet and outlet Point modules. A calculation level basic valve component (BV01\_VA1) is also created as well as a thermal control exception module (BV01\_TE1). Thermal control exception module allows the user to add exceptions to the general calculation parameters. The attributes of this module type are listed in [**TH\_CONTROL\_EXCEPTION**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/thermref/Th_control_exception.html).

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**Attributes**

|  |  |  |
| --- | --- | --- |
| *Table 2. Attributes, units and descriptions* | | |
| **ATTRIBUTE** **Property name** | **Unit** | **Description** |
| VA11\_CONNECT\_POINT\_1 Name of inlet connection point | ­- | is the name of the first connection point |
| VA11\_CONNECT\_POINT\_2 Name of outlet connection point | - | is the name of the second connection point |
| VA11\_AREA\_GIVEN Is diameter or area given as input | - | If the value of the attribute is 2, the outside diameter and the thickness of the first layer of the valve wall are given as input values, the inside diameter is calculated from these values and the flow area is calculated from the inside diameter assuming a circular cross section. If the value of the attribute is 1, the flow area of the valve is given as an input value. If the value of the attribute is 0, the inside diameter is given as an input value and the flow area is calculated from the inside diameter assuming a circular cross section. |
| VA11\_OUTSIDE\_DIAM Outside diameter of valve | mm | is the outside diameter of the valve. If the value of the attribute VA11\_AREA\_GIVEN is 2, the outside diameter is given as an input value, the inside diameter is calculated from the outside diameter and the thickness of the first layer of the valve wall and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA11\_AREA\_GIVEN is 0 or 1, the outside diameter is calculated from the relevant input parameters. |
| VA11\_INSIDE\_DIAM Inside diameter of valve | mm | is the inside diameter of the valve. If the value of the attribute VA11\_AREA\_GIVEN is 0, the inside diameter is given as an input value and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA11\_AREA\_GIVEN is 1 or 2, the inside diameter is calculated from the relevant input parameters assuming a circular cross section. |
| VA11\_AREA Flow area | m2 | is the flow area of the valve. If the value of the attribute VA11\_AREA\_GIVEN is 1, the area is given as an input value. If the value of the attribute VA11\_AREA\_GIVEN is 0 or 2, the area is calculated from the relevant input parameters assuming a circular cross section. |
| VA11\_LENGTH Flow length of valve | m | is the length of the valve |
| VA11\_ACCURACY\_LEVEL Flow model | ­- | is the accuracy level on which the valve is connected to the branch, it must be either 1, 2, 5 or 6. The accuracy level has to be given only if a valve is added from the APROS command window. Otherwise the accuracy level is automatically searched from the connection points of the valve. |
| VA11\_MIX\_MASS\_FLOW Mass flow | kg/s | is the mass flow of the valve |
| VA11\_LIQ\_MASS\_FLOW Liquid mass flow | kg/s | is the liquid mass flow of the valve |
| VA11\_GAS\_MASS\_FLOW Gas mass flow | kg/s | is the gas mass flow of the valve |
| VA11\_LOSS\_COEFF Loss coefficient of fully open valve | - | is the loss coefficient of a fully open valve |
| VA11\_FORM\_LOSS Form loss coefficient | - | is the form loss coefficient of the valve. The pressure loss over the valve is calculated with the sum of the valve loss coefficient depending on the valve position and the form loss coefficient that can be used to model additional losses. |
| VA11\_DISCHARGE\_COEFF Discharge coefficient | - | defines the discharge coefficient. If the critical flow is checked in the valve, the critical flow given by the Moody model is multiplied by the discharge coefficient. The coefficient defines the ratio of the effective flow area in the break orifice and the total area of the orifice. The value of the coefficient should normally be between 0.6 (sharp-edged break orifice) and 1 (ideally smoothed orifice). |
| VA11\_RELAX\_COEFF Relaxation coefficient of mass flow | - | is the relaxation coefficient used in the calculation of the mass flow in the valve. The relaxation coefficient is used if the valve is defined between the homogeneous and five-equation models, between the homogeneous and six-equation models, between the homogeneous model and level 0 thermohydraulics or between the homogeneous and containment models. If the value of the relaxation coefficient is e.g. 0.7, the new mass flow is 0.7 \* the mass flow calculated from the matrix coefficients of the pressure-flow solution + 0.3 \* the mass flow of the previous time step. If the relaxation coefficient is 1, there is no relaxation. The coefficient has to be > 0 and <= 1. The use of the relaxation coefficient makes the changes of mass flow slower but may make the solution more stable. |
| VA11\_DROPLET\_FRACTION Droplet fraction | - | is the fraction of liquid flow of the valve going into droplets in the connected containment model node (the rest of the liquid flow goes to the liquid pool). The fraction is used if the elevation of the valve is above the liquid level of the containment model node. |
| VA11\_NONC\_GAS\_RATIO Air excess in flow | - | defines how much more noncondensable gas (air) compared to the average air mass fraction is transferred with the flow in the valve. The value 0 means that the air mass fraction of the valve is the same as the air mass fraction of the upwind node (calculated in the gas phase). The variable VA11NR is used in the calculation as follows: the used air fraction Xair = (1 + VA11NR) Xair,up where Xair,up is the air mass fraction of the upwind node. Negative values (-1 < VA11NR < 0) can also be used and then the flow includes less air than the upwind air fraction indicates. The calculated air mass fraction is limited between 0 and 1. The attribute is used when the accuracy level of the input and output points of the valve is 2 or 6 (when the accuracy level is 2, the WG or EP section has to be selected in the points). The attribute is used only when the mass flow of the valve is positive. |
| VA11\_PARALLEL\_CONNECTION Transfer of momentum over the valve | - | The value 0 means that momentum is not transferred over the valve. The values 1 and 2 mean that momentum is transferred over the valve. The difference between values 1 and 2 is the way how momentum is divided between parallel calculation level branches. The value 1 means that the whole momentum flow coming into a node (the sum of momentum flows of branches transferring momentum and flowing towards the node) is divided between the branches going out of the node and transferring momentum. The value 2 means that the incoming momentum flow multiplied by the sum of the mass flows in the branches going out of the node and transferring momentum and divided by the sum of all mass flows going out of the node is divided between the branches going out of the node and transferring momentum. |
| VA11\_AREA\_CHANGE\_TERM Is area change correction to momentum used | - | defines whether a correction term due to flow area change is calculated in the momentum equation (value 1) or not (value 0). The area change term is calculated if VA11\_AREA\_CHANGE\_TERM = 1 and VA11\_PARALLEL\_CONNECTION = 1 or 2. |
| VA11\_EXPLICIT\_CONNECTION Explicit connection | - | defines whether the branch created by the valve takes part implicitly or explicitly in the pressure solution. The value 0 means that the branch takes part implicitly, 1 means that the contribution to the first connection point is explicit and 2 that the contribution to the second connection point is explicit. An explicit connection is recommended to be used only if the mass flow in the valve is small compared to the mass of the connection point to which the connection is explicit. |
| VA11\_CONNECT\_EXPERIMENTS Connection between two experiments | - | defines whether the valve connects two experiments defining two separately solved processes in multi-processor simulation (value 1 or 2) or not (value 0). If the value of the attribute is 1 or 2, the valve creates one branch where flow is solved, one external branch and two external nodes. The external modules define boundary conditions for the two processes and their state is updated from the branch in solution and the connection points of the valve. If the value of the attribute is 1, the external branch is connected to the second connection point. The value 2 means that the external branch is connected to the first connection point. |
| VA11\_SPRAY\_CALC Spray calculation | - | defines whether the liquid flow of the valve is used as input for the spray calculation of the containment model (value 1) or not (value 0). The attribute is used only if the valve is connected to a containment model node (one of the connection points is either a point of accuracy level 4 or a containment model node (module type CN1\_NODE)). |
| VA11\_POSITION Position of valve | - | is the position of the valve |
| VA11\_POSITION\_SET\_POINT Position set point of valve | - | defines the position set point of the valve. If electricity is available and no malfunction has been defined, the position of the valve follows the set point according to the driving time of the valve. If the driving time is 0, the position of the valve follows the set point without delay. |
| VA11\_DRIVING\_TIME Driving time of valve | s | is the driving time of the valve from a fully open position to a fully closed position |
| VA11\_CRIT\_FLOW Is critical flow checked | - | is 1, if the flow in the valve is restricted to the critical flow (otherwise 0) |
| VA11\_CLOSED\_VALVE\_CALC Treatment of a closed valve | - | defines the calculation for a completely closed valve. The value 1 means that the flow through a closed valve is set to 0. The value 2 means that a small flow goes through a closed valve. The value 2 is recommended if the closing of the valve forms an isolated subsystem where the flow in all nodes has been defined as uncompressible. If the accuracy level of both connection points is 5, the flow through a closed valve is never set to 0. |
| VA11\_LEAK\_POSITION Leak position for flow through a closed valve | - | defines the valve position used in the calculation of the loss coefficient for a fully closed valve. The value can be used to tune the flow through a closed valve and it has an effect, if VA11\_CLOSED\_VALVE\_CALC = 2. |
| VA11\_MALFUNCTION Malfunction | - | defines a malfunction (fault) in the valve. = 0: no malfunction, = 1: the valve is stuck, = 2: the valve is opened, = 3: the valve is closed. If a malfunction is defined, the effect of automation and electrical systems on the valve calculation is ignored. |
| VA11\_AUTOM\_CREATED Is device controller created | - | is TRUE, if a device controller is created |
| VA11\_HS\_CREATED Is wall heat structure created | - | If the value 1 is given, a heat structure representing the wall of the valve is created. |
| VA11\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | is the thickness of the first layer in the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA11\_HS\_CREATED, VA11\_HS\_THICKNESS\_1 and VA11\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA11\_HS\_THICKNESS\_2 Thickness of second layer in the wall | mm | is the thickness of the second layer in the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA11\_HS\_CREATED, VA11\_HS\_THICKNESS\_1, VA11\_HS\_NUMBER\_RAD\_1, VA11\_HS\_THICKNESS\_2 and VA11\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA11\_HS\_THICKNESS\_3 Thickness of third layer in the wall | mm | is the thickness of the third layer in the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA11\_HS\_CREATED, VA11\_HS\_THICKNESS\_1, VA11\_HS\_NUMBER\_RAD\_1, VA11\_HS\_THICKNESS\_3 and VA11\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA11\_HS\_MATERIAL\_1 Material number of first layer in the wall | - | is the number defining the material of the first layer of the heat structure representing the wall of the valve (see [**HSM\_MATERIAL**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html#Predefined_materials) for the possible values) |
| VA11\_HS\_MATERIAL\_2 Material number of second layer in the wall | - | is the number defining the material of the second layer of the heat structure representing the wall of the valve |
| VA11\_HS\_MATERIAL\_3 Material number of third layer in the wall | - | is the number defining the material of the third layer of the heat structure representing the wall of the valve |
| VA11\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | - | is the number of heat structure nodes in the radial direction in the first layer of the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA11\_HS\_CREATED, VA11\_HS\_THICKNESS\_1 and VA11\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA11\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | - | is the number of heat structure nodes in the radial direction in the second layer of the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA11\_HS\_CREATED, VA11\_HS\_THICKNESS\_1, VA11\_HS\_NUMBER\_RAD\_1, VA11\_HS\_THICKNESS\_2 and VA11\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA11\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | - | is the number of heat structure nodes in the radial direction in the third layer of the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA11\_HS\_CREATED,  VA11\_HS\_THICKNESS\_1, VA11\_HS\_NUMBER\_RAD\_1, VA11\_HS\_THICKNESS\_3 and VA11\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA11\_HEAT\_COND\_AXI Is axial heat conduction solved | - | defines whether axial heat conduction is calculated on the wall of the valve (value 1) or not (value 0) |
| VA11\_SPRAY\_MODULE Name of outlet spray module | - | defines the name of the internal spray module where the flow of the valve is transferred if the valve is a spray valve (the value of the attribute VA11\_SPRAY\_CALC is 1). If no spray module name is given, the spray module connected to the input or output node of the valve (a node of the containment model) is automatically searched. If more than one spray modules are connected to the node, the user has to define the correct spray module using this attribute. The module type of the spray module must be CNI\_SPRAY. |
| VA11\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | defines the name of the containment model node where the concentrations (e.g. the boron concentration) are transferred if the valve is a spray valve (the value of the attribute VA11\_SPRAY\_CALC is 1). If no name is given or the valve is not a spray valve, the input or output node of the valve (a node of the containment model) is automatically used if a sump is connected to the node. If no sump is connected to the node, the node connected to the drain water sump of the input or output node of the valve is searched. The name of the outlet node for spray concentrations should be defined, if no sump is connected to the node where the spray flow goes. The module type of the node must be CN1\_NODE. |
| VA11\_BUSBAR\_NAME Name of busbar to supply electricity | - | is the name of the busbar (ES\_NODE module) which the valve is connected to |
| VA11\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | defines the name of a binary signal indicating whether the valve has electricity (signal value TRUE) or not (value FALSE). The binary signal value is used if no busbar name is given in the attribute VA11\_BUSBAR\_NAME. If the busbar and binary signal names are not defined, it is assumed that the valve has electricity. |
| VA11\_VOLUME Volume of valve | m3 | shows the volume of the valve (= flow area ∙ length) |
| VA11\_VELOCITY Flow velocity | m/s | shows the flow velocity of the valve |
| VA11\_LIQ\_VELOC Liquid velocity | m/s | shows the velocity of the liquid phase |
| VA11\_GAS\_VELOC Gas velocity | m/s | shows the velocity of the gas phase |
| VA11\_MIX\_VOL\_FLOW Volumetric flow | m3/s | shows the volumetric flow of the valve |
| VA11\_PRESSURE\_LOSS Pressure loss | MPa | shows the total pressure loss over the valve consisting of wall friction, friction caused by the form loss coefficient and the valve loss coefficient and irreversible losses due to change of flow area and change of momentum flux between successive branches. The pressure loss is: the total pressure at the valve inlet - the total pressure at the valve outlet - the hydrostatic pressure difference of the valve. If the valve is connected to a combination module, the attribute shows the total pressure loss of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. If the mass flow of the valve is positive, the total pressure at the valve inlet is the total pressure of the input point. If the mass flow is negative, the total pressure at the valve inlet is: the static pressure of the input point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. If the mass flow of the valve is negative, the total pressure at the valve outlet is the total pressure of the output point. If the mass flow is positive, the total pressure at the valve outlet is: the static pressure of the output point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. |
| VA11\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | MPa | shows the pressure loss over the valve caused by wall friction. If the valve is connected to a combination module, the attribute shows the total pressure loss due to wall friction of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA11\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | MPa | shows the pressure loss over the valve caused by the form loss coefficient and the valve loss coefficient. If the valve is connected to a combination module, the attribute shows the total pressure loss due to form loss coefficients, valve loss coefficients and pump loss coefficients of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA11\_LOSS\_OTHER Other pressure losses | MPa | shows the irreversible pressure loss over the valve due to the change of flow area and the change of momentum flux between successive branches. If e.g. the value of the attribute VA11\_PARALLEL\_CONNECTION is 0 and 2 (or 1) in successive valves, a considerable pressure loss may occur in the latter valve because the flow is assumed to accelerate from 0. The pressure loss is updated if the accuracy level of both connection points is either 2 or 6. |
| VA11\_CONTROLLED Is valve position controlled | - | has the value TRUE, if the position of the valve is controlled by an actuator or a device controller. Otherwise the value of the attribute is FALSE. |
| VA11\_SECTION\_NAME Name of fluid | - | shows the name of the SECTION module defining the composition of the fluid. The section name is searched from the connection points |
| VA11\_HEAT\_POINT\_NAME Name of generated heat point | - | shows the name of the created HEAT\_POINT module. A HEAT\_TRANS module can be connected to the heat point to describe the heat transfer from the outer surface of the valve wall |
| VA11\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | shows the names of the binary signals created by the valve |
| VA11\_ANALOG\_SIGNAL\_NAME Name of created analog signal | - | shows the name of the analog signal created by the valve |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Table 3. Attributes, default values, input/output-types, use in Flow models 1...6* | | | | | | |
| **ATTRIBUTE** **Property name** | **Default value** | **Input / Output** | **Flow model (accuracy level L1...L6)** | | | |
| **L1** | **L2** | **L5** | **L6** |
| VA11\_CONNECT\_POINT\_1 Name of inlet connection point | - | I | x | x | x | x |
| VA11\_CONNECT\_POINT\_2 Name of outlet connection point | - | I | x | x | x | x |
| VA11\_AREA\_GIVEN Is diameter or area given as input | 2 | I | x | x | x | x |
| VA11\_OUTSIDE\_DIAM Outside diameter of valve | 100 | I or O | x | x | x | x |
| VA11\_INSIDE\_DIAM Inside diameter of valve | 100 | I or O | x | x | x | x |
| VA11\_AREA Flow area | 0.01 | I or O | x | x | x | x |
| VA11\_LENGTH Flow length of valve | 1 | I | x | x | x | x |
| VA11\_ACCURACY\_LEVEL Flow model | 2 | I or O | x | x | x | x |
| VA11\_MIX\_MASS\_FLOW Mass flow | 0 | Note: | I | I | O | O |
| VA11\_LIQ\_MASS\_FLOW Liquid mass flow | 0 | Note: | O | O | I | I |
| VA11\_GAS\_MASS\_FLOW Gas mass flow | 0 | Note: | O | O | I | I |
| VA11\_LOSS\_COEFF Loss coefficient of fully open valve | 1 | I | x | x | x | x |
| VA11\_FORM\_LOSS Form loss coefficient | 0 | I | x | x | x | x |
| VA11\_DISCHARGE\_COEFF Discharge coefficient | 0.75 | I |  | x |  | x |
| VA11\_RELAX\_COEFF Relaxation coefficient of mass flow | 1 | I |  | x | x | x |
| VA11\_DROPLET\_FRACTION Droplet fraction | 0.2 | I |  | x | x | x |
| VA11\_NONC\_GAS\_RATIO Air excess in flow | 0 | I |  | x |  | x |
| VA11\_PARALLEL\_CONNECTION Transfer of momentum over the valve | 0 | I |  | x |  | x |
| VA11\_AREA\_CHANGE\_TERM Is area change correction to momentum used | 0 | I |  | x |  | x |
| VA11\_EXPLICIT\_CONNECTION Explicit connection | 0 | I |  | x |  |  |
| VA11\_CONNECT\_EXPERIMENTS Connection between two experiments | 0 | I |  | x |  | x |
| VA11\_SPRAY\_CALC Spray calculation | 0 | I |  | x | x | x |
| VA11\_POSITION Position of valve | 1 | I | x | x | x | x |
| VA11\_POSITION\_SET\_POINT Position set point of valve | 1 | I | x | x | x | x |
| VA11\_DRIVING\_TIME Driving time of valve | 0 | I | x | x | x | x |
| VA11\_CRIT\_FLOW Is critical flow checked | 0 | I |  | x |  | x |
| VA11\_CLOSED\_VALVE\_CALC Treatment of a closed valve | 1 | I | x | x | x | x |
| VA11\_LEAK\_POSITION Leak position for flow through a closed valve | 0 | I | x | x | x | x |
| VA11\_MALFUNCTION Malfunction | 0 | I | x | x | x | x |
| VA11\_AUTOM\_CREATED Is device controller created | FALSE | I | x | x | x | x |
| VA11\_HS\_CREATED Is wall heat structure created | 0 | I | x | x | x | x |
| VA11\_HS\_THICKNESS\_1 Thickness of first layer in the wall | 0 | I | x | x | x | x |
| VA11\_HS\_THICKNESS\_2 Thickness of second layer in the wall | 0 | I | x | x | x | x |
| VA11\_HS\_THICKNESS\_3 Thickness of third layer in the wall | 0 | I | x | x | x | x |
| VA11\_HS\_MATERIAL\_1 Material number of first layer in the wall | 5 | I | x | x | x | x |
| VA11\_HS\_MATERIAL\_2 Material number of second layer in the wall | 5 | I | x | x | x | x |
| VA11\_HS\_MATERIAL\_3 Material number of third layer in the wall | 5 | I | x | x | x | x |
| VA11\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | 2 | I | x | x | x | x |
| VA11\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | 1 | I | x | x | x | x |
| VA11\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | 1 | I | x | x | x | x |
| VA11\_HEAT\_COND\_AXI Is axial heat conduction solved | 0 | I | x | x | x | x |
| VA11\_SPRAY\_MODULE Name of outlet spray module | - | I |  | x | x | x |
| VA11\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | I |  | x | x | x |
| VA11\_BUSBAR\_NAME Name of busbar to supply electricity | - | I | x | x | x | x |
| VA11\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | I | x | x | x | x |
| VA11\_VOLUME Volume of valve | - | O | x | x | x | x |
| VA11\_VELOCITY Flow velocity | - | O | x | x | x | x |
| VA11\_LIQ\_VELOC Liquid velocity | - | O | x | x | x | x |
| VA11\_GAS\_VELOC Gas velocity | - | O | x | x | x | x |
| VA11\_MIX\_VOL\_FLOW Volumetric flow | - | O | x | x | x | x |
| VA11\_PRESSURE\_LOSS Pressure loss | - | O |  | x |  | x |
| VA11\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | - | O |  | x |  | x |
| VA11\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | - | O |  | x |  | x |
| VA11\_LOSS\_OTHER Other pressure losses | - | O |  | x |  | x |
| VA11\_CONTROLLED Is valve position controlled | - | O | x | x | x | x |
| VA11\_SECTION\_NAME Name of fluid | - | O | x | x | x | x |
| VA11\_HEAT\_POINT\_NAME Name of generated heat point | - | O | x | x | x | x |
| VA11\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | O | x | x | x | x |
| VA11\_ANALOG\_SIGNAL\_NAME Name of created analog signal | - | O | x | x | x | x |

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**Special**

Heat transfer is calculated between the heat structure and the connection points of the valve (unless the Flow model of a connection point is 0 or 1 or the valve is part of a COMBINATION module). The heat structure consists of one, two or three layers of different materials.  
If the Flow model of the outlet connection point is 0 or 4, the valve has the same Flow model as the inlet connection point. The following combinations of Flow models for the two connection points are allowed: 0-1, 0-2, 1-0, 1-1, 1-2, 1-5, 1-6, 2-0, 2-1, 2-2, 2-4, 2-5, 2-6, 4-2, 4-5, 4-6, 5-1, 5-2, 5-4, 5-5, 6-1, 6-2, 6-4 and 6-6. If the valve is connected to the containment model, see more in [**Connection of thermal hydraulic and containment models**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/contref/th-cont_connection.pdf) (Note! Link valid only in Containment Apros version).

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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
[**Main Table of Contents**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/index.htm)

**SHUT\_OFF\_VALVE**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\126EBACD.tmp | Shut-off Valve |

**Contents**

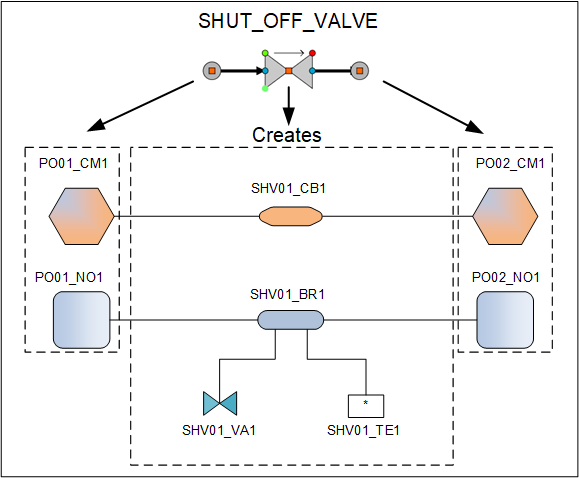
[**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Shut_off_valve.html#Introduction)  
[**Structure**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Shut_off_valve.html#Structure)  
[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Shut_off_valve.html#Attributes)  
[**Special**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Shut_off_valve.html#Special)  
[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
[**Main Table of Contents**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/index.htm)

**Introduction**

The user specifies the valve type by means of the input number. If desired, the system also creates the device controller for opening and closing the valve and a heat structure representing the wall of the valve. Heat transfer is calculated between the heat structure and the connection points of the valve (unless the Flow model of a connection point is 0 or 1 or the valve is part of a COMBINATION module). The valve can be connected to the Flow model 0, 1 (one-phase model), 2 (homogeneous model), 4 (containment model), 5 (five-equation model) or 6 (six-equation model) and the Flow model of the valve is usually the same as the Flow model of the outlet connection point.

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**Structure**

*Figure 1. Calculation level structure of a simple SHUT\_OFF\_VALVE connection*

[**List of symbols**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Module_type_documentation_format.html#List_of_symbols)

Consider a SHUT\_OFF\_VALVE connected to two points. The created structure is shown in Figure 1 and the relevant parameters for this kind of a calculation level structure are shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Relevant input parameters for a simple SHUT\_OFF\_VALVE* | | | |
| **Attribute Property name** | **Unit** | **Value** | **Note** |
| VA13\_LENGTH Flow length of valve | m | 1 |  |
| VA13\_AREA\_GIVEN Is diameter or area given as input | - | 2 | The outside diameter and wall thickness are given as input parameters and the flow area is calculated from them |
| VA13\_OUTSIDE\_DIAM Outside diameter of valve | mm | 100 |  |
| VA13\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | 10 |  |
| VA13\_SHUT\_TIME Driving time of valve | s | 30 |  |
| VA13\_VALVE\_TYPE Valve type | - | 1 |  |
| VA13\_LOSS\_COEFF Form loss coefficient | - | 1 |  |
| VA13\_DISCHARGE\_COEFF Discharge coefficient | - | 0.75 |  |

The SHUT\_OFF\_VALVE creates two branches, one for thermal hydraulic calculation (SHV01\_BR1) and the other for composition calculation (SHV01\_CB1). Branches are connected to nodes of the inlet and outlet POINT modules. Shut-off valve also creates a calculation level shut-off valve (SHV01\_VA1) as well as a thermal control exception module (SHV01\_TE1). Thermal control exception module allows the user to add exceptions to the general calculation parameters. The attributes of this module type are listed in [**TH\_CONTROL\_EXCEPTION**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/thermref/Th_control_exception.html).

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**Attributes**

|  |  |  |
| --- | --- | --- |
| *Table 2. Attributes, units and descriptions* | | |
| **ATTRIBUTE** **Property name** | **Unit** | **Description** |
| VA13\_CONNECT\_POINT\_1 Name of inlet connection point | - | is the name of the first connection point |
| VA13\_CONNECT\_POINT\_2 Name of outlet connection point | ­- | is the name of the second connection point |
| VA13\_AREA\_GIVEN Is diameter or area given as input | - | If the value of the attribute is 2, the outside diameter and the thickness of the first layer of the valve wall are given as input values, the inside diameter is calculated from these values and the flow area is calculated from the inside diameter assuming a circular cross section. If the value of the attribute is 1, the flow area of the valve is given as an input value. If the value of the attribute is 0, the inside diameter is given as an input value and the flow area is calculated from the inside diameter assuming a circular cross section. |
| VA13\_OUTSIDE\_DIAM Outside diameter of valve | mm | is the outside diameter of the valve. If the value of the attribute VA13\_AREA\_GIVEN is 2, the outside diameter is given as an input value, the inside diameter is calculated from the outside diameter and the thickness of the first layer of the valve wall and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA13\_AREA\_GIVEN is 0 or 1, the outside diameter is calculated from the relevant input parameters. |
| VA13\_INSIDE\_DIAM Inside diameter of valve | mm | is the inside diameter of the valve. If the value of the attribute VA11\_AREA\_GIVEN is 0, the inside diameter is given as an input value and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA13\_AREA\_GIVEN is 1 or 2, the inside diameter is calculated from the relevant input parameters assuming a circular cross section. |
| VA13\_AREA Flow area | m2 | is the flow area of the valve. If the value of the attribute VA13\_AREA\_GIVEN is 1, the area is given as an input value. If the value of the attribute VA13\_AREA\_GIVEN is 0 or 2, the area is calculated from the relevant input parameters assuming a circular cross section. |
| VA13\_LENGTH Flow length of valve | m | is the length of the valve |
| VA13\_LOSS\_COEFF Form loss coefficient | - | is the form loss coefficient of the valve. The form loss coefficient is added to the valve loss coefficient calculated from the specific curve of the valve and it can be used to tune the mass flow. |
| VA13\_VALVE\_TYPE Valve type | - | is the number of the valve type. = 1 is a wedge­ type gate valve, = 2 is a butterfly valve, = 3 is a stopcock valve, = 4 is a flap valve, = 5 is a disk valve without bottom guides, = 6 is a conical valve on a conical seat, = 7 is a conical valve on a flat seat, = 8 is a direct ­flow globe valve, = 9 is a valve with a linear specific curve, = 10 is a valve with an equal percentual specific curve. This attribute is used if the value of the attribute VA13\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA13\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | - | defines whether the Kv- or Cv-values of the valve are given. Possible values are: 0: not given 1: Kv-value for a fully open valve is given in the attribute VA13\_KV\_CV\_COEFF and the valve is assumed to be linear 2: Kv-value for a fully open valve is given in the attribute VA13\_KV\_CV\_COEFF and the valve is assumed to be equal percentual. 3: Kv-curve is given in the attribute VA13\_KV\_CV\_CURVES (Kv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. 101: Cv-value for a fully open valve is given in the attribute VA13\_KV\_CV\_COEFF and the valve is assumed to be linear 102: Cv-value for a fully open valve is given in the attribute VA13\_KV\_CV\_COEFF and the valve is assumed to be equal percentual. 103: Cv-curve is given in the attribute VA13\_KV\_CV\_CURVES (Cv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. Notice! When this attribute has larger value than 0, it is assumed that in spite of the value of the attribute VA13\_VALVE\_TYPE this attribute is dominant. |
| VA13\_LOSS\_COEFF\_OPEN Loss coefficient of fully open valve | - | is the loss coefficient of a fully open valve. This attribute is used if the value of the attribute VA13\_KV\_CV\_VALUE\_GIVEN is 0 and the value of the attribute VA13\_VALVE\_TYPE is 9 or 10. |
| VA13\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | m3/h/bar\*\*1/2 (Kv) or US gal/min/psi\*\*1/2 (Cv) | is the Kv- or Cv-value of a fully open valve (volumetric flow). This attribute is used if the value of the attribute VA13\_KV\_CV\_VALUE\_GIVEN is 1, 2, 101 or 102. |
| VA13\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | -,m3/h/bar\*\*1/2 (Kv) or -,US gal/min/psi\*\*1/2 (Cv) | Kv- or Cv-values as a function of valve position (position 0 … 1, valve capacity). Up to 30 point pairs may be given. The valve positions in the given points have to be in increasing order. This attribute is used if the value of the attribute VA13\_KV\_CV\_VALUE\_GIVEN is 3 or 103. For further information please look at the documentation of the [**CALC\_SHUT\_OFF\_VALVE**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/calcref/Calc_shut_off_valve.html#VO_KV_CV_CURVES). |
| VA13\_SHUT\_TIME Driving time of valve | s | is the driving time of the valve |
| VA13\_ACCURACY\_LEVEL Flow model | - | is the accuracy level on which the valve is connected to the branch, it must be either 1, 2, 5 or 6. The accuracy level has to be given only if a valve is added from the APROS command window. Otherwise the accuracy level is automatically searched from the connection points of the valve. |
| VA13\_MIX\_MASS\_FLOW Mass flow | kg/s | is the mass flow of the valve |
| VA13\_LIQ\_MASS\_FLOW Liquid mass flow | kg/s | is the liquid mass flow of the valve |
| VA13\_GAS\_MASS\_FLOW Gas mass flow | kg/s | is the gas mass flow of the valve |
| VA13\_DISCHARGE\_COEFF Discharge coefficient | - | defines the discharge coefficient. If the critical flow is checked in the valve, the critical flow given by the Moody model is multiplied by the discharge coefficient. The coefficient defines the ratio of the effective flow area in the break orifice and the total area of the orifice. The value of the coefficient should normally be between 0.6 (sharp-edged break orifice) and 1 (ideally smoothed orifice). |
| VA13\_RELAX\_COEFF Relaxation coefficient of mass flow | - | is the relaxation coefficient used in the calculation of the mass flow in the valve. The relaxation coefficient is used if the valve is defined between the homogeneous and five-equation models, between the homogeneous and six-equation models, between the homogeneous model and level 0 thermohydraulics or between the homogeneous and containment models.. If the value of the relaxation coefficient is e.g. 0.7, the new mass flow is 0.7 \* the mass flow calculated from the matrix coefficients of the pressure-flow solution + 0.3 \* the mass flow of the previous time step. If the relaxation coefficient is 1, there is no relaxation. The coefficient has to be > 0 and <= 1. The use of the relaxation coefficient makes the changes of mass flow slower but may make the solution more stable. |
| VA13\_PARALLEL\_CONNECTION Transfer of momentum over the valve | - | The value 0 means that momentum is not transferred over the valve. The values 1 and 2 mean that momentum is transferred over the valve. The difference between values 1 and 2 is the way how momentum is divided between parallel calculation level branches. The value 1 means that the whole momentum flow coming into a node (the sum of momentum flows of branches transferring momentum and flowing towards the node) is divided between the branches going out of the node and transferring momentum. The value 2 means that the incoming momentum flow multiplied by the sum of the mass flows in the branches going out of the node and transferring momentum and divided by the sum of all mass flows going out of the node is divided between the branches going out of the node and transferring momentum. |
| VA13\_AREA\_CHANGE\_TERM Is area change correction to momentum used | - | defines whether a correction term due to flow area change is calculated in the momentum equation (value 1) or not (value 0). The area change term is calculated if VA13\_AREA\_CHANGE\_TERM = 1 and VA13\_PARALLEL\_CONNECTION = 1 or 2. |
| VA13\_DROPLET\_FRACTION Droplet fraction | - | is the fraction of liquid flow of the valve going into droplets in the connected containment model node (the rest of the liquid flow goes to the liquid pool). The fraction is used if the elevation of the valve is above the liquid level of the containment model node. |
| VA13\_NONC\_GAS\_RATIO Air excess in flow | - | defines how much more noncondensable gas (air) compared to the average air mass fraction is transferred with the flow in the valve. The value 0 means that the air mass fraction of the valve is the same as the air mass fraction of the upwind node (calculated in the gas phase). The variable VA13NR is used in the calculation as follows: the used air fraction Xair = (1 + VA13NR) Xair,up where Xair,up is the air mass fraction of the upwind node. Negative values (-1 < VA13NR < 0) can also be used and then the flow includes less air than the upwind air fraction indicates. The calculated air mass fraction is limited between 0 and 1. The attribute is used when the accuracy level of the input and output points of  the valve is 2 or 6 (when the accuracy level is 2, the WG or EP section has to be selected in the points). The attribute is used only when the mass flow of the valve is positive. |
| VA13\_EXPLICIT\_CONNECTION Explicit connection | - | defines whether the branch created by the valve takes part implicitly or explicitly in the pressure solution. = 0 means that the branch takes part implicitly, = 1 means that the contribution to the first connection point is explicit and = 2 that the contribution to the second connection point is explicit. An explicit connection is recommended to be used only if the mass flow in the valve is small compared to the mass of the connection point to which the connection is explicit. |
| VA13\_CONNECT\_EXPERIMENTS Connection between two experiments | - | defines whether the valve connects two experiments defining two separately solved processes in multi-processor simulation (value 1 or 2) or not (value 0). If the value of the attribute is 1 or 2, the valve creates one branch where flow is solved, one external branch and two external nodes. The external modules define boundary conditions for the two processes and their state is updated from the branch in solution and the connection points of the valve. If the value of the attribute is 1, the external branch is connected to the second connection point. The value 2 means that the external branch is connected to the first connection point. |
| VA13\_SPRAY\_CALC Spray calculation | - | defines whether the liquid flow of the valve is used as input for the spray calculation of the containment model (value 1) or not (value 0). The attribute is used only if the valve is connected to a containment model node (one of the connection points is either a point of accuracy level 4 or a containment model node (module type CN1\_NODE)). |
| VA13\_POSITION\_SET\_POINT Position set point of valve | - | is the input position of the valve (position set point) |
| VA13\_CRIT\_FLOW Is critical flow checked | - | is 1, if the flow in the valve is restricted to the critical flow (otherwise 0) |
| VA13\_CLOSED\_VALVE\_CALC Treatment of a closed valve | - | defines the calculation for a completely closed valve. = 1 means that the flow through a closed valve is set to 0. = 2 means that a small flow goes through a closed valve. The value 2 is recommended if the closing of the valve forms an isolated subsystem where the flow in all nodes has been defined as uncompressible. If the accuracy level of both connection points is 5, the flow through a closed valve is never set to 0. |
| VA13\_LEAK\_POSITION Leak position for flow through a closed valve | - | defines the valve position used in the calculation of the loss coefficient for a fully closed valve. The value can be used to tune the flow through a closed valve and it has an effect, if VA13\_CLOSED\_VALVE\_CALC = 2. |
| VA13\_MALFUNCTION Malfunction | - | defines a malfunction (fault) in the valve. = 0: no malfunction, = 1: the valve is stuck, = 2: the valve is opened, = 3: the valve is closed. If a malfunction is defined, the effect of automation and electrical systems on the valve calculation is ignored. |
| VA13\_AUTOM\_CREATED Is device controller created | - | is TRUE if a device controller is created |
| VA13\_HS\_CREATED Is wall heat structure created | - | If the value 1 is given, a heat structure representing the wall of the valve is created. |
| VA13\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | is the thickness of the first layer in the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1 and VA13\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA13\_HS\_THICKNESS\_2 Thickness of second layer in the wall | mm | is the thickness of the second layer in the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1, VA13\_HS\_NUMBER\_RAD\_1, VA13\_HS\_THICKNESS\_2 and VA13\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA13\_HS\_THICKNESS\_3 Thickness of third layer in the wall | mm | is the thickness of the third layer in the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1, VA13\_HS\_NUMBER\_RAD\_1, VA13\_HS\_THICKNESS\_3 and VA13\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA13\_HS\_MATERIAL\_1 Material number of first layer in the wall | - | is the number defining the material of the first layer of the heat structure representing the wall of the valve (see [**HSM\_MATERIAL**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html#Predefined_materials) for the possible values) |
| VA13\_HS\_MATERIAL\_2 Material number of second layer in the wall | - | is the number defining the material of the second layer of the heat structure representing the wall of the valve |
| VA13\_HS\_MATERIAL\_3 Material number of third layer in the wall | - | is the number defining the material of the third layer of the heat structure representing the wall of the valve |
| VA13\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | - | is the number of heat structure nodes in the radial direction in the first layer of the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1 and VA13\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA13\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | - | is the number of heat structure nodes in the radial direction in the second layer of the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1, VA13\_HS\_NUMBER\_RAD\_1, VA13\_HS\_THICKNESS\_2 and VA13\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA13\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | - | is the number of heat structure nodes in the radial direction in the third layer of the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA13\_HS\_CREATED, VA13\_HS\_THICKNESS\_1, VA13\_HS\_NUMBER\_RAD\_1, VA13\_HS\_THICKNESS\_3 and VA13\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA13\_HEAT\_COND\_AXI Is axial heat conduction solved | - | defines whether axial heat conduction is calculated on the wall of the valve (value 1) or not (value 0) |
| VA13\_SPRAY\_MODULE Name of outlet spray module | - | defines the name of the internal spray module where the flow of the valve is transferred if the valve is a spray valve (the value of the attribute VA13\_SPRAY\_CALC is 1). If no spray module name is given, the spray module connected to the input or output node of the valve (a node of the containment model) is automatically searched. If more than one spray modules are connected to the node, the user has to define the correct spray module using this attribute. The module type of the spray module must be CNI\_SPRAY. |
| VA13\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | defines the name of the containment model node where the concentrations (e.g. the boron concentration) are transferred if the valve is a spray valve (the value of the attribute VA13\_SPRAY\_CALC is 1). If no name is given or the valve is not a spray valve, the input or output node of the valve (a node of the containment model) is automatically used if a sump is connected to the node. If no sump is connected to the node, the node connected to the drain water sump of the input or output node of the valve is searched. The name of the outlet node for spray concentrations should be defined, if no sump is connected to the node where the spray flow goes. The module type of the node must be CN1\_NODE. |
| VA13\_BUSBAR\_NAME Name of busbar to supply electricity | - | is the name of the busbar (ES\_NODE module) which the valve is connected to |
| VA13\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | defines the name of a binary signal indicating whether the valve has electricity (signal value TRUE) or not (value FALSE). The binary signal value is used if no busbar name is given in the attribute VA13\_BUSBAR\_NAME. If the busbar and binary signal names are not defined, it is assumed that the valve has electricity. |
| VA13\_EXTERNAL\_ACTION Valve behaviour when external power is lost | - | is the type of the action, if the external power is lost. = 1: valve position remains unchanged, = 2: the valve will close, = 3: the valve will open |
| VA13\_EXTERNAL\_LOSS\_TIME Closing time when external power is lost | - | is the closing time of the valve if the external power is lost |
| VA13\_VOLUME Volume of valve | m3 | shows the volume of the valve (= flow area ∙ length) |
| VA13\_VELOCITY Flow velocity | m/s | shows the flow velocity of the valve |
| VA13\_LIQ\_VELOC Liquid velocity | m/s | shows the velocity of the liquid phase |
| VA13\_GAS\_VELOC Gas velocity | m/s | shows the velocity of the gas phase |
| VA13\_MIX\_VOL\_FLOW Volumetric flow | m3/s | shows the volumetric flow of the valve |
| VA13\_PRESSURE\_LOSS Pressure loss | MPa | shows the total pressure loss over the valve consisting of wall friction, friction caused by the form loss coefficient and the valve loss coefficient and irreversible losses due to change of flow area and change of momentum flux between successive branches. The pressure loss is: the total pressure at the valve inlet - the total pressure at the valve outlet - the hydrostatic pressure difference of the valve. If the valve is connected to a combination module, the attribute shows the total pressure loss of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. If the mass flow of the valve is positive, the total pressure at the valve inlet is the total pressure of the input point. If the mass flow is negative, the total pressure at the valve inlet is: the static pressure of the input point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. If the mass flow of the valve is negative, the total pressure at the valve outlet is the total pressure of the output point. If the mass flow is positive, the total pressure at the valve outlet is: the static pressure of the output point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. |
| VA13\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | MPa | shows the pressure loss over the valve caused by wall friction. If the valve is connected to a combination module, the attribute shows the total pressure loss due to wall friction of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA13\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | MPa | shows the pressure loss over the valve caused by the form loss coefficient and the valve loss coefficient. If the valve is connected to a combination module, the attribute shows the total pressure loss due to form loss coefficients, valve loss coefficients and pump loss coefficients of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA13\_LOSS\_OTHER Other pressure losses | MPa | shows the irreversible pressure loss over the valve due to the change of flow area and the change of momentum flux between successive branches. If e.g. the value of the attribute VA13\_PARALLEL\_CONNECTION is 0 and 2 (or 1) in successive valves, a considerable pressure loss may occur in the latter valve because the flow is assumed to accelerate from 0. The pressure loss is updated if the accuracy level of both connection points is either 2 or 6. |
| VA13\_POSITION Position of valve | - | shows the position of the valve |
| VA13\_CONTROLLED Is valve position controlled | - | has the value TRUE, if the position of the valve is controlled by an actuator or a device controller. Otherwise the value of the attribute is FALSE. |
| VA13\_SECTION\_NAME Name of fluid | - | shows the name of the SECTION module defining the composition of the fluid. The section name is searched from the connection points |
| VA13\_HEAT\_POINT\_NAME Name of generated heat point | - | shows the name of the created HEAT\_POINT module. A HEAT\_TRANS module can be connected to the heat point to describe the heat transfer from the outer surface of the valve wall |
| VA13\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | includes the names of the binary signals created by the valve |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Table 3. Attributes, default values, input/output-types and use in Flow models 1...6* | | | | | | |
| **ATTRIBUTE** **Property name** | **Default value** | **Input / Output** | **Flow model (accuracy level L1...L6)** | | | |
| **L1** | **L2** | **L5** | **L6** |
| VA13\_CONNECT\_POINT\_1 Name of inlet connection point | - | I | x | x | x | x |
| VA13\_CONNECT\_POINT\_2 Name of outlet connection point | - | I | x | x | x | x |
| VA13\_AREA\_GIVEN Is diameter or area given as input | 2 | I | x | x | x | x |
| VA13\_OUTSIDE\_DIAM Outside diameter of valve | 100 | I or O | x | x | x | x |
| VA13\_INSIDE\_DIAM Inside diameter of valve | 100 | I or O | x | x | x | x |
| VA13\_AREA Flow area | 0.01 | I or O | x | x | x | x |
| VA13\_LENGTH Flow length of valve | 1 | I | x | x | x | x |
| VA13\_LOSS\_COEFF Form loss coefficient | 0 | I | x | x | x | x |
| VA13\_VALVE\_TYPE Valve type | 9 | I | x | x | x | x |
| VA13\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | 0 | I | x | x | x | x |
| VA13\_LOSS\_COEFF\_OPEN Loss coefficient of fully open valve | 1 | I | x | x | x | x |
| VA13\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | 360 | I | x | x | x | x |
| VA13\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | 0 | I | x | x | x | x |
| VA13\_SHUT\_TIME Driving time of valve | 30 | I | x | x | x | x |
| VA13\_ACCURACY\_LEVEL Flow model | 2 | I or O | x | x | x | x |
| VA13\_MIX\_MASS\_FLOW Mass flow | 0 | Note: | I | I | O | O |
| VA13\_LIQ\_MASS\_FLOW Liquid mass flow | 0 | Note: | O | O | I | I |
| VA13\_GAS\_MASS\_FLOW Gas mass flow | 0 | Note: | O | O | I | I |
| VA13\_DISCHARGE\_COEFF Discharge coefficient | 0.75 | I |  | x |  | x |
| VA13\_RELAX\_COEFF Relaxation coefficient of mass flow | 1 | I |  | x | x | x |
| VA13\_PARALLEL\_CONNECTION Transfer of momentum over the valve | 0 | I |  | x |  | x |
| VA13\_AREA\_CHANGE\_TERM Is area change correction to momentum used | 0 | I |  | x |  | x |
| VA13\_DROPLET\_FRACTION Droplet fraction | 0.2 | I |  | x | x | x |
| VA13\_NONC\_GAS\_RATIO Air excess in flow | 0 | I |  | x |  | x |
| VA13\_EXPLICIT\_CONNECTION Explicit connection | 0 | I |  | x |  |  |
| VA13\_CONNECT\_EXPERIMENTS Connection between two experiments | 0 | I |  | x |  | x |
| VA13\_SPRAY\_CALC Spray calculation | 0 | I |  | x | x | x |
| VA13\_POSITION\_SET\_POINT Position set point of valve | 0 | I | x | x | x | x |
| VA13\_CRIT\_FLOW Is critical flow checked | 0 | I |  | x |  | x |
| VA13\_CLOSED\_VALVE\_CALC Treatment of a closed valve | 1 | I | x | x | x | x |
| VA13\_LEAK\_POSITION Leak position for flow through a closed valve | 0 | I | x | x | x | x |
| VA13\_MALFUNCTION Malfunction | 0 | I | x | x | x | x |
| VA13\_AUTOM\_CREATED Is device controller created | FALSE | I | x | x | x | x |
| VA13\_HS\_CREATED Is wall heat structure created | 0 | I | x | x | x | x |
| VA13\_HS\_THICKNESS\_1 Thickness of first layer in the wall | 0 | I | x | x | x | x |
| VA13\_HS\_THICKNESS\_2 Thickness of second layer in the wall | 0 | I | x | x | x | x |
| VA13\_HS\_THICKNESS\_3 Thickness of third layer in the wall | 0 | I | x | x | x | x |
| VA13\_HS\_MATERIAL\_1 Material number of first layer in the wall | 5 | I | x | x | x | x |
| VA13\_HS\_MATERIAL\_2 Material number of second layer in the wall | 5 | I | x | x | x | x |
| VA13\_HS\_MATERIAL\_3 Material number of third layer in the wall | 5 | I | x | x | x | x |
| VA13\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | 2 | I | x | x | x | x |
| VA13\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | 1 | I | x | x | x | x |
| VA13\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | 1 | I | x | x | x | x |
| VA13\_HEAT\_COND\_AXI Is axial heat conduction solved | 0 | I | x | x | x | x |
| VA13\_SPRAY\_MODULE Name of outlet spray module | - | I |  | x | x | x |
| VA13\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | I |  | x | x | x |
| VA13\_BUSBAR\_NAME Name of busbar to supply electricity | - | I | x | x | x | x |
| VA13\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | I | x | x | x | x |
| VA13\_EXTERNAL\_ACTION Valve behaviour when external power is lost | 1 | I | x | x | x | x |
| VA13\_EXTERNAL\_LOSS\_TIME Closing time when external power is lost | 5 | I | x | x | x | x |
| VA13\_VOLUME Volume of valve | - | O | x | x | x | x |
| VA13\_VELOCITY Flow velocity | - | O | x | x | x | x |
| VA13\_LIQ\_VELOC Liquid velocity | - | O | x | x | x | x |
| VA13\_GAS\_VELOC Gas velocity | - | O | x | x | x | x |
| VA13\_MIX\_VOL\_FLOW Volumetric flow | - | O | x | x | x | x |
| VA13\_PRESSURE\_LOSS Pressure loss | - | O |  | x |  | x |
| VA13\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | - | O |  | x |  | x |
| VA13\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | - | O |  | x |  | x |
| VA13\_LOSS\_OTHER Other pressure losses | - | O |  | x |  | x |
| VA13\_POSITION Position of valve | - | O | x | x | x | x |
| VA13\_CONTROLLED Is valve position controlled | - | O | x | x | x | x |
| VA13\_SECTION\_NAME Name of fluid | - | O | x | x | x | x |
| VA13\_HEAT\_POINT\_NAME Name of generated heat point | - | O | x | x | x | x |
| VA13\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | O | x | x | x | x |

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**Special**

Heat transfer is calculated between the heat structure and the connection points of the valve (unless the Flow model of a connection point is 0 or 1 or the valve is part of a COMBINATION module). The heat structure consists of one, two or three layers of different materials.  
If the Flow model of the outlet connection point is 0 or 4, the valve has the same Flow model as the inlet connection point. The following combinations of Flow models for the two connection points are allowed: 0-1, 0-2, 1-0, 1-1, 1-2, 1-5, 1-6, 2-0, 2-1, 2-2, 2-4, 2-5, 2-6, 4-2, 4-5, 4-6, 5-1, 5-2, 5-4, 5-5, 6-1, 6-2, 6-4 and 6-6. If the valve is connected to the containment model, see more in [**Connection of thermal hydraulic and containment models**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/contref/th-cont_connection.pdf) (Note! Link valid only in Containment Apros version).

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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
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**CALC\_SHUT\_OFF\_VALVE**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\A1C69669.tmp | Shut-off Valve, Calculation Level |

**Contents**

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[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/calcref/Calc_shut_off_valve.html#Attributes)  
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**Introduction**

The shut­-off valve model calculates the flow resistance caused by the shut­-off valve. The valve model is connected to the thermal hydraulic branch and it can be controlled by the automation system. It can also be used without the automation system.  
The user can choose from 8 different kinds of shut­off valves, which all have different kinds of flow resistance curves between positions fully closed and opened. The flow resistance curves are presented in the program documents of the valves. Also a linear or equal percentual curve can be chosen or Kv- or Cv-values of the valve given.

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**Attributes**

|  |  |  |
| --- | --- | --- |
| *Table 1. Attributes, units and descriptions* | | |
| **ATTRIBUTE** **Property name** | **Unit** | **Description** |
| VO\_BRANCH Name of branch connected to valve | - | defines the name of the branch that the valve is connected to. The module type of the branch must be either BR1\_BRANCH, BR2\_BRANCH, BR5\_BRANCH, BR6\_BRANCH, BR10\_BRANCH, BR12\_BRANCH, BR15\_BRANCH, BR16\_BRANCH, BR20\_BRANCH, BR25\_BRANCH, BR26\_BRANCH, BR2CN\_BRANCH, BR5CN\_BRANCH, BR6CN\_BRANCH, CN1\_BRANCH or CN2\_BRANCH. |
| VO\_DIMENSION Inside diameter of valve | m | is the inside diameter of the valve |
| VO\_VALVE\_TYPE Valve type | - | is the type of the shut­off valve: 1= wedge­ type gate valve; 2= butterfly valve; 3= stopcock valve; 4= flap valve; 5= disk valve without bottom guides; 6= conical valve on conical seat; 7= conical valve on flat seat and ball valve on spherical seat; 8= direct ­flow globe valve, 9= valve with a linear specific curve, 10= valve with an equal percentual specific curve. Notice! This attribute is used only when the attribute VO\_KV\_CV\_VALUE\_GIVEN has the value 0. |
| VO\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | - | =0, not given. If =1, Kv -value for a fully open value given and the valve is assumed to be linear. If =2, fully open Kv-value given and the valve is assumed to be equal percentual. If =101, Cv -value for a fully open value given and the valve is assumed to be linear. If =102, fully open Cv-value given and the valve is assumed to be equal percentual. In case the attribute has value 1, 2, 101 or 102 the fully open value has to be given using attribute VO\_KV\_CV\_COEFF. If =3, the Kv -curve is given (Kv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. If =103, the Cv -curve is given (Cv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. Notice! When this attribute has larger value than 0, it is assumed that in spite of the value of the attribute VO\_VALVE\_TYPE this attribute is dominant. |
| VO\_LOSS\_COEFF Loss coefficient of fully open valve | - | is the loss coefficient of a fully open valve. This attribute is used if the value of the attribute VO\_KV\_CV\_VALUE\_GIVEN is 0 and the value of the attribute VO\_VALVE\_TYPE is 9 or 10. |
| VO\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | m3/h/bar\*\*1/2 (Kv) or US gal/min/psi\*\*1/2 (Cv) | Kv- or Cv-value of a fully open valve. This attribute has to be given when the attribute VO\_KV\_CV\_VALUE\_GIVEN has the value 1, 2, 101 or 102. |
| VO\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | 0..1,m3/h/bar\*\*1/2 (Kv) or 0..1, US gal/min/psi\*\*1/2 (Cv) | Kv- or Cv-values as a function of valve position (position 0 …1, valve capacity). Up to 30 point pairs may be given. The valve positions in the given points have to be in increasing order. This attribute has to be given when VO\_KV\_CV\_VALUE\_GIVEN has the value 3 or 103. The valve manufacturers give the valve characteristics with the aid of the flow coefficient Kv. The flow coefficient is given to the valves of the different size as a function of the valve position. The volumetric flow is calculated with the following formula , where  = volumetric flow (m3/h), = pressure loss over the valve (bar) and   = ratio of the real density to the density at 4 °C. If Cv is given instead of Kv, the formula is the same but the units are different: US gal/min (volumetric flow) and psi (pressure loss). |
| VO\_POSITION Position of valve | - | is the initial position of the valve. During simulation the position is changed if an open- or close-command is given or the position set point is changed. |
| VO\_POSITION\_SET\_POINT Position set point of valve | - | is the position set point of the valve. If neither open- or close-command has been given, the position of the valve is calculated according to the set point. |
| VO\_SHUT\_TIME Driving time of valve | s | is the driving time of the valve from a fully open position to a fully closed position |
| VO\_DISK\_BREADTH Disk breadth of disk valve | m | is the disk breadth of a disk valve without bottom guides |
| VO\_CLOSED\_VALVE\_CALC Treatment of a closed valve | - | defines the calculation for a completely closed valve. The value 1 means that the flow through a closed valve is set to 0. The value 2 means that a small flow goes through a closed valve. The value 2 is recommended if the closing of the valve forms an isolated subsystem of the homogeneous model where the flow in all nodes has been defined as incompressible. If the valve is connected to a branch of the five-equation model (module type BR5\_BRANCH), the flow through a closed valve is never set to 0. |
| VO\_LEAK\_POSITION Leak position for flow through a closed valve | - | defines the valve position used in the calculation of the loss coefficient for a fully closed valve. The value can be used to tune the flow through a closed valve and it has an effect, if VO\_CLOSED\_VALVE\_CALC = 2. |
| VO\_EXTERNAL\_ACTION Valve behaviour when external power is lost | - | tells the function of the actuator when electricity is lost ; 1 = the valve will remain at the current position; 2 = the valve will close; 3 = the valve will open |
| VO\_EXTER\_LOSS\_TIME Closing time when external power is lost | s | is the driving time of the valve when electricity is lost |
| VO\_MALFUNCTION Malfunction | - | defines a malfunction (fault) in the valve. The following values are possible: 0: no malfunction 1: the valve is stuck 2: the valve is opened 3: the valve is closed If a malfunction is defined, the effect of automation and electrical systems on the valve calculation is ignored. |
| VO\_VALVE\_OPEN Is the valve fully open | - | tells if the valve is fully open |
| VO\_VALVE\_CLOSE Is the valve fully closed | - | tells if the valve is fully closed |
| VO\_OPEN Is the valve wanted to open | - | is true if the valve is wanted to open |
| VO\_CLOSE Is the valve wanted to close | - | is true if the valve is wanted to close |
| VO\_BUSBAR\_NAME Name of busbar to supply electricity | - | defines the name of the busbar (ES\_NODE module) from which the valve gets its power. If the voltage in the busbar is sufficient, the attribute VO\_ELECTRICITY\_ON gets the value TRUE and the valve functions normally. If the busbar is not defined, the availability of electricity is checked from the binary signal defined in the attribute VO\_ELEC\_SIGNAM. If the busbar and binary signal names are not defined, the electricity is assumed to be available. |
| VO\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | defines the name of a binary signal indicating whether the valve has electricity (signal value TRUE) or not (value FALSE). The binary signal value is used if no busbar name is given in the attribute VO\_BUSBAR\_NAME. If the busbar and binary signal names are not defined, it is assumed that the valve has electricity. |
| VO\_ELECTRICITY\_ON Is electricity available to the valve | - | shows whether electricity is available to the valve |

|  |  |  |
| --- | --- | --- |
| *Table 2. Attributes, default values and input/output-types* | | |
| **ATTRIBUTE** **Property name** | **Default value** | **Input / Output** |
| VO\_BRANCH Name of branch connected to valve | - | I |
| VO\_DIMENSION Inside diameter of valve | 0.1 | I |
| VO\_VALVE\_TYPE Valve type | 9 | I |
| VO\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | 0 | I |
| VO\_LOSS\_COEFF Loss coefficient of fully open valve | 1 | I |
| VO\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | 360 | I |
| VO\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | 0 | I |
| VO\_POSITION Position of valve | 0 | I/O |
| VO\_POSITION\_SET\_POINT Position set point of valve | 0 | I |
| VO\_SHUT\_TIME Driving time of valve | 30 | I |
| VO\_DISK\_BREADTH Disk breadth of disk valve | 0.1 | I |
| VO\_CLOSED\_VALVE\_CALC Treatment of a closed valve | 1 | I |
| VO\_LEAK\_POSITION Leak position for flow through a closed valve | 0 | I |
| VO\_EXTERNAL\_ACTION Valve behaviour when external power is lost | 1 | I |
| VO\_EXTER\_LOSS\_TIME Closing time when external power is lost | 30 | I |
| VO\_MALFUNCTION Malfunction | 0 | I |
| VO\_VALVE\_OPEN Is the valve fully open | - | O |
| VO\_VALVE\_CLOSE Is the valve fully closed | - | O |
| VO\_OPEN Is the valve wanted to open | TRUE | I |
| VO\_CLOSE Is the valve wanted to close | FALSE | I |
| VO\_BUSBAR\_NAME Name of busbar to supply electricity | - | I |
| VO\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | I |
| VO\_ELECTRICITY\_ON Is electricity available to the valve | - | O |

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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
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**SAFETY\_VALVE**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\8D91C297.tmp | Safety Valve |

**Contents**

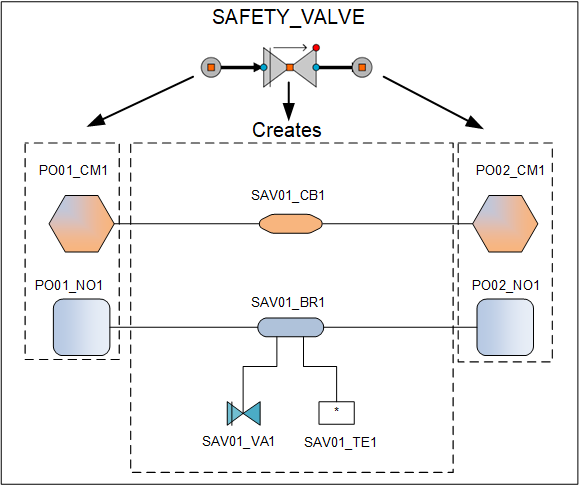
[**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Safety_valve.html#Introduction)  
[**Structure**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Safety_valve.html#Structure)  
[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Safety_valve.html#Attributes)  
[**Special**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Safety_valve.html#Special)  
[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
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**Introduction**

The SAFETY\_VALVE module calculates the flow resistance as a function of pressure. If desired, the system also creates a heat structure representing the wall of the valve. The valve can be connected to the Flow models 0, 2 (homogeneous model), 4 (containment model), 5 (five-equation model) or 6 (six-equation model) and the Flow model of the valve is usually the same as the Flow model of the outlet connection point.

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**Structure**

*Figure 1. Calculation level structure of a simple SAFETY\_VALVE connection*

[**List of symbols**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Module_type_documentation_format.html#List_of_symbols)

Consider a SAFETY\_VALVE connected to two points. The created structure is shown in Figure 1 and the relevant parameters for this kind of a calculation level structure are shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Relevant input parameters for a simple SAFETY\_VALVE* | | | |
| **Attribute Property name** | **Unit** | **Value** | **Note** |
| VA16\_LENGTH Flow length of valve | m | 1 |  |
| VA16\_AREA\_GIVEN Is diameter or area given as input | - | 2 | The outside diameter and wall thickness are given as input parameters and the flow area is calculated from them |
| VA16\_OUTSIDE\_DIAM Outside diameter of valve | mm | 100 |  |
| VA16\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | 10 |  |
| VA16\_VALVE\_TYPE Valve type | - | 1 |  |
| VA16\_OPENING\_PRESSURE Opening pressure | MPa | 15 |  |
| VA16\_CLOSING\_PRESSURE Closing pressure | MPa | 10 |  |
| VA16\_CAPACITY\_MAX Maximum mass flow through the valve | kg/s | 100 |  |
| VA16\_PRESSURE\_MAX Pressure corresponding maximum mass flow | MPa | 20 |  |

The SAFETY\_VALVE creates two branches, one for thermal hydraulic calculation (SAV01\_BR1) and the other for composition calculation (SAV01\_CB1). Branches are connected to nodes of the inlet and outlet POINT modules. Safety valve also creates a calculation level safety valve (SAV01\_VA1) as well as a thermal control exception module (SAV01\_TE1). Thermal control exception module allows the user to add exceptions to the general calculation parameters. The attributes of this module type are listed in [**TH\_CONTROL\_EXCEPTION**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/thermref/Th_control_exception.html).

[**To contents of this component**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Safety_valve.html#Contents)

**Attributes**

|  |  |  |
| --- | --- | --- |
| *Table 2. Attributes, units and descriptions* | | |
| **ATTRIBUTE** **Property name** | **Unit** | **Description** |
| VA16\_CONNECT\_POINT\_1 Name of inlet connection point | ­- | is the name of the first connection point |
| VA16\_CONNECT\_POINT\_2 Name of outlet connection point | ­- | is the name of the second connection point |
| VA16\_AREA\_GIVEN Is diameter or area given as input | - | If the value of the attribute is 1, the flow area of the valve is given as an input value. If the value of the attribute is 0, the inside diameter is given as an input value and the flow area is calculated from the inside diameter assuming a circular cross section. If the value of the attribute is 2, the outside diameter and the thickness of the first layer of the valve wall are given as input values, the inside diameter is calculated from these values and the flow area is calculated from the inside diameter assuming a circular cross section. |
| VA16\_OUTSIDE\_DIAM Outside diameter of valve | mm | is the outside diameter of the valve. If the value of the attribute VA16\_AREA\_GIVEN is 2, the outside diameter is given as an input value, the inside diameter is calculated from the outside diameter and the thickness of the first layer of the valve wall and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA16\_AREA\_GIVEN is 0 or 1, the outside diameter is calculated from the relevant input parameters. |
| VA16\_INSIDE\_DIAM Inside diameter of valve | mm | is the inside diameter of the valve. If the value of the attribute VA16\_AREA\_GIVEN is 0, the inside diameter is given as an input value and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA16\_AREA\_GIVEN is 1 or 2, the inside diameter is calculated from the relevant input parameters assuming a circular cross section. |
| VA16\_AREA Flow area | m2 | is the flow area of the valve. If the value of the attribute VA16\_AREA\_GIVEN is 1, the area is given as an input value. If the value of the attribute VA16\_AREA\_GIVEN is 0 or 2, the area is calculated from the relevant input parameters assuming a circular cross section. |
| VA16\_LENGTH Flow length of valve | m | is the length of the valve |
| VA16\_VALVE\_TYPE Valve type | - | is the type of the valve, = 1: liquid safety valve, = 2: gas safety valve, = 3 : valve whose opening and closing curves are given. If the value of the attribute is 1 or 2, the opening and closing curves of the valve are automatically fitted to the given opening pressure, closing pressure and pressure causing the maximum flow. |
| VA16\_OPENING\_PRESSURE Opening pressure | MPa | is the opening pressure of the valve. If the value of the attribute VA16\_VALVE\_TYPE is 1 or 2, the opening pressure is given as an input value. If the value of the attribute VA16\_VALVE\_TYPE is 3, the opening pressure is searched from the opening curve and shown in this attribute. |
| VA16\_CLOSING\_PRESSURE Closing pressure | MPa | is the closing pressure of the valve. If the value of the attribute VA16\_VALVE\_TYPE is 1 or 2, the closing pressure is given as an input value. If the value of the attribute VA16\_VALVE\_TYPE is 3, the closing pressure is searched from the closing curve and shown in this attribute. |
| VA16\_CAPACITY\_MAX Maximum mass flow through the valve | kg/s | is the maximum mass flow through the valve (when the valve is fully open) |
| VA16\_PRESSURE\_MAX Pressure corresponding maximum mass flow | MPa | is the pressure that causes maximum mass flow (pressure where the valve is fully open). If the value of the attribute VA16\_VALVE\_TYPE is 1 or 2, the pressure is given as an input value. If the value of the attribute VA16\_VALVE\_TYPE is 3, the pressure is searched from the opening curve and shown in this attribute. |
| VA16\_DENSITY\_AVE Density corresponding maximum mass flow | kg/m3 | is the average density corresponding to the maximum mass flow (when the valve is fully open) |
| VA16\_POPPING\_PRESSURE Pressure of popping point | MPa | is the pressure in the popping point of the valve. When the inlet pressure of the valve goes over the opening pressure, the valve starts to open following the opening curve. If the inlet pressure goes over the popping pressure, the closing of the valve follows the closing curve. If the inlet pressure does not go over the popping pressure, the closing of the valve follows the opening curve. This attribute is used, if the value of the attribute VA16\_VALVE\_TYPE is 3. |
| VA16\_OPENING\_CURVE Opening curve | MPa, - | defines the opening curve of the valve. The points of the curve define the inlet pressure of the valve and the corresponding valve position. Up to 20 points may be given. The pressures and valve positions in the given points have to be in increasing order. When the pressure between a pair of points is non-increasing, it signifies the end of the given points. If the pressure goes outside the given points during simulation, the first or last point is used. All the pressures should be positive. The position of the first point should be 0 and the position of the last point should be 1. The pressure of the first point defines the opening pressure of the valve. The pressure of the last point defines the pressure causing the maximum mass flow. This attribute is used, if the value of the attribute VA16\_VALVE\_TYPE is 3. |
| VA16\_CLOSING\_CURVE Closing curve | MPa, - | defines the closing curve of the valve. The points of the curve define the inlet pressure of the valve and the corresponding valve position. Up to 20 points may be given. The pressures and valve positions in the given points have to be in increasing order. When the pressure between a pair of points is non-increasing, it signifies the end of the given points. If the pressure goes outside the given points during simulation, the first or last point is used. All the pressures should be positive. The position of the first point should be 0 and the position of the last point should be 1. The pressure of the first point defines the closing pressure of the valve. This attribute is used, if the value of the attribute VA16\_VALVE\_TYPE is 3. |
| VA16\_CLOSED\_VALVE\_COEFF Loss coefficient of fully closed valve | - | is the loss coefficient of a fully closed valve |
| VA16\_ACCURACY\_LEVEL Flow model | - | is the accuracy level on which the valve is connected to the branch, it must be either 2, 5 or 6. The accuracy level has to be given only if a valve is added from the APROS command window. Otherwise the accuracy level is automatically searched from the connection points of the valve. |
| VA16\_MIX\_MASS\_FLOW Mass flow | kg/s | is the mixture mass flow of the valve |
| VA16\_LIQ\_MASS\_FLOW Liquid mass flow | kg/s | is the liquid mass flow of the valve |
| VA16\_GAS\_MASS\_FLOW Gas mass flow | kg/s | is the gas mass flow of the valve |
| VA16\_DISCHARGE\_COEFF Discharge coefficient | - | defines the discharge coefficient. If the critical flow is checked in the valve, the critical flow given by the Moody model is multiplied by the discharge coefficient. The coefficient defines the ratio of the effective flow area in the break orifice and the total area of the orifice. The value of the coefficient should normally be between 0.6 (sharp-edged break orifice) and 1 (ideally smoothed orifice). |
| VA16\_RELAX\_COEFF Relaxation coefficient of mass flow | - | is the relaxation coefficient used in the calculation of the mass flow in the valve. The relaxation coefficient is used if the valve is defined between the homogeneous and five-equation models, between the homogeneous and six-equation models, between the homogeneous model and level 0 thermohydraulics or between the homogeneous and containment models. If the value of the relaxation coefficient is e.g. 0.7, the new mass flow is 0.7 \* the mass flow calculated from the matrix coefficients of the pressure-flow solution + 0.3 \* the mass flow of the previous time step. If the relaxation coefficient is 1, there is no relaxation. The coefficient has to be > 0 and <= 1. The use of the relaxation coefficient makes the changes of mass flow slower but may make the solution more stable. |
| VA16\_RELAX\_COEFF\_PRES Relaxation coefficient of inlet pressure | - | is the relaxation coefficient of the inlet pressure of the valve. The use of the relaxation coefficient should make the solution more stable when the inlet pressure of the valve is close to the opening pressure. If e.g. the value 0.1 is given, the pressure used in the valve calculation is 0.1 \* the new solved inlet pressure + 0.9 \* the valve inlet pressure used during the previous iteration. If the relaxation coefficient is 1, there is no relaxation. The coefficient has to be > 0 and <= 1. |
| VA16\_DROPLET\_FRACTION Droplet fraction | - | is the fraction of liquid flow of the valve going into droplets in the connected containment model node (the rest of the liquid flow goes to the liquid pool). The fraction is used if the elevation of the valve is above the liquid level of the containment model node. |
| VA16\_NONC\_GAS\_RATIO Air excess in flow | - | defines how much more noncondensable gas (air) compared to the average air mass fraction is transferred with the flow in the valve. The value 0 means that the air mass fraction of the valve is the same as the air mass fraction of the upwind node (calculated in the gas phase). The variable VA16NR is used in the calculation as follows: the used air fraction Xair = (1 + VA16NR) Xair,up where Xair,up is the air mass fraction of the upwind node. Negative values (-1 < VA16NR < 0) can also be used and then the flow includes less air than the upwind air fraction indicates. The calculated air mass fraction is limited between 0 and 1. The attribute is used when the accuracy level of the input and output points of the valve is 2 or 6 (when the accuracy level is 2, the WG or EP section has to be selected in the points). The attribute is used only when the mass flow of the valve is positive. |
| VA16\_PARALLEL\_CONNECTION Transfer of momentum over the valve | - | The value 0 means that momentum is not transferred over the valve. The values 1 and 2 mean that momentum is transferred over the valve. The difference between values 1 and 2 is the way how momentum is divided between parallel calculation level branches. The value 1 means that the whole momentum flow coming into a node (the sum of momentum flows of branches transferring momentum and flowing towards the node) is divided between the branches going out of the node and transferring momentum. The value 2 means that the incoming momentum flow multiplied by the sum of the mass flows in the branches going out of the node and transferring momentum and divided by the sum of all mass flows going out of the node is divided between the branches going out of the node and transferring momentum. |
| VA16\_AREA\_CHANGE\_TERM Is area change correction to momentum used | - | defines whether a correction term due to flow area change is calculated in the momentum equation (value 1) or not (value 0). The area change term is calculated if VA16\_AREA\_CHANGE\_TERM = 1 and VA16\_PARALLEL\_CONNECTION = 1 or 2. |
| VA16\_EXPLICIT\_CONNECTION Explicit connection | - | defines whether the branch created by the valve takes part implicitly or explicitly in the pressure solution. The value 0 means that the branch takes part implicitly, 1 means that the contribution to the first connection point is explicit and 2 that the contribution to the second connection point is explicit. An explicit connection is recommended to be used only if the mass flow in the valve is small compared to the mass of the connection point to which the connection is explicit. |
| VA16\_CONNECT\_EXPERIMENTS Connection between two experiments | - | defines whether the valve connects two experiments defining two separately solved processes in multi-processor simulation (value 1 or 2) or not (value 0). If the value of the attribute is 1 or 2, the valve creates one branch where flow is solved, one external branch and two external nodes. The external modules define boundary conditions for the two processes and their state is updated from the branch in solution and the connection points of the valve. If the value of the attribute is 1, the external branch is connected to the second connection point. The value 2 means that the external branch is connected to the first connection point. |
| VA16\_SPRAY\_CALC Spray calculation | - | defines whether the liquid flow of the valve is used as input for the spray calculation of the containment model (value 1) or not (value 0). The attribute is used only if the valve is connected to a containment model node (one of the connection points is either a point of accuracy level 4 or a containment model node (module type CN1\_NODE)). |
| VA16\_CRIT\_FLOW Is critical flow checked | - | is 1, if the flow in the valve is restricted to the critical flow (otherwise 0) |
| VA16\_CLOSED\_VALVE\_CALC Treatment of a closed valve | - | defines the calculation for a completely closed valve. The value 1 means that the flow through a closed valve is set to 0. The value 2 means that a small flow goes through a closed valve. The value 2 is recommended if the closing of the valve forms an isolated subsystem where the flow in all nodes has been defined as uncompressible. If the accuracy level of both connection points is 5, the flow through a closed valve is never set to 0. The flow through a closed valve can be tuned with the loss coefficient (attribute VA16\_CLOSED\_VALVE\_COEFF). |
| VA16\_DRIVING\_TIME Driving time of valve | s | is the driving time of the valve from a fully open position to a fully closed position |
| VA16\_MALFUNCTION Malfunction | - | defines a malfunction (fault) in the valve. = 0: no malfunction, = 1: the valve is stuck, = 2: the valve is opened, = 3: the valve is closed. |
| VA16\_HS\_CREATED Is wall heat structure created | - | If the value 1 is given, a heat structure representing the wall of the valve is created. |
| VA16\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | is the thickness of the first layer in the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1 and VA16\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA16\_HS\_THICKNESS\_2 Thickness of second layer in the wall | mm | is the thickness of the second layer in the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1, VA16\_HS\_NUMBER\_RAD\_1, VA16\_HS\_THICKNESS\_2 and VA16\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA16\_HS\_THICKNESS\_3 Thickness of third layer in the wall | mm | is the thickness of the third layer in the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1, VA16\_HS\_NUMBER\_RAD\_1, VA16\_HS\_THICKNESS\_3 and VA16\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA16\_HS\_MATERIAL\_1 Material number of first layer in the wall | - | is the number defining the material of the first layer of the heat structure representing the wall of the valve (see [**HSM\_MATERIAL**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html#Predefined_materials) for the possible values) |
| VA16\_HS\_MATERIAL\_2 Material number of second layer in the wall | - | is the number defining the material of the second layer of the heat structure representing the wall of the valve |
| VA16\_HS\_MATERIAL\_3 Material number of third layer in the wall | - | is the number defining the material of the third layer of the heat structure representing the wall of the valve |
| VA16\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | - | is the number of heat structure nodes in the radial direction in the first layer of the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1 and VA16\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA16\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | - | is the number of heat structure nodes in the radial direction in the second layer of the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1, VA16\_HS\_NUMBER\_RAD\_1, VA16\_HS\_THICKNESS\_2 and VA16\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA16\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | - | is the number of heat structure nodes in the radial direction in the third layer of the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA16\_HS\_CREATED, VA16\_HS\_THICKNESS\_1, VA16\_HS\_NUMBER\_RAD\_1, VA16\_HS\_THICKNESS\_3 and VA16\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA16\_HEAT\_COND\_AXI Is axial heat conduction solved | - | defines whether axial heat conduction is calculated on the wall of the valve (value 1) or not (value 0) |
| VA16\_SPRAY\_MODULE Name of outlet spray module | - | defines the name of the internal spray module where the flow of the valve is transferred if the valve is a spray valve (the value of the attribute VA16\_SPRAY\_CALC is 1). If no spray module name is given, the spray module connected to the input or output node of the valve (a node of the containment model) is automatically searched. If more than one spray modules are connected to the node, the user has to define the correct spray module using this attribute. The module type of the spray module must be CNI\_SPRAY. |
| VA16\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | defines the name of the containment model node where the concentrations (e.g. the boron concentration) are transferred if the valve is a spray valve (the value of the attribute VA16\_SPRAY\_CALC is 1). If no name is given or the valve is not a spray valve, the input or output node of the valve (a node of the containment model) is automatically used if a sump is connected to the node. If no sump is connected to the node, the node connected to the drain water sump of the input or output node of the valve is searched. The name of the outlet node for spray concentrations should be defined, if no sump is connected to the node where the spray flow goes. The module type of the node must be CN1\_NODE. |
| VA16\_VOLUME Volume of valve | m3 | shows the volume of the valve (= flow area ∙ length) |
| VA16\_VELOCITY Flow velocity | m/s | shows the flow velocity of the valve |
| VA16\_LIQ\_VELOC Liquid velocity | m/s | shows the velocity of the liquid phase |
| VA16\_GAS\_VELOC Gas velocity | m/s | shows the velocity of the gas phase |
| VA16\_MIX\_VOL\_FLOW Volumetric flow | m3/s | shows the volumetric flow of the valve |
| VA16\_PRESSURE\_LOSS Pressure loss | MPa | shows the total pressure loss over the valve consisting of wall friction, friction caused by the form loss coefficient and the valve loss coefficient and irreversible losses due to change of flow area and change of momentum flux between successive branches. The pressure loss is: the total pressure at the valve inlet - the total pressure at the valve outlet - the hydrostatic pressure difference of the valve. If the valve is connected to a combination module, the attribute shows the total pressure loss of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. If the mass flow of the valve is positive, the total pressure at the valve inlet is the total pressure of the input point. If the mass flow is negative, the total pressure at the valve inlet is: the static pressure of the input point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. If the mass flow of the valve is negative, the total pressure at the valve outlet is the total pressure of the output point. If the mass flow is positive, the total pressure at the valve outlet is: the static pressure of the output point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. |
| VA16\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | MPa | shows the pressure loss over the valve caused by wall friction. If the valve is connected to a combination module, the attribute shows the total pressure loss due to wall friction of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA16\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | MPa | shows the pressure loss over the valve caused by the valve loss coefficient. If the valve is connected to a combination module, the attribute shows the total pressure loss due to form loss coefficients, valve loss coefficients and pump loss coefficients of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA16\_LOSS\_OTHER Other pressure losses | MPa | shows the irreversible pressure loss over the valve due to the change of flow area and the change of momentum flux between successive branches. If e.g. the value of the attribute VA16\_PARALLEL\_CONNECTION is 0 and 2 (or 1) in successive valves, a considerable pressure loss may occur in the latter valve because the flow is assumed to accelerate from 0. The pressure loss is updated if the accuracy level of both connection points is either 2 or 6. |
| VA16\_POSITION Position of valve | - | shows the position of the valve |
| VA16\_SECTION\_NAME Name of fluid | - | shows the name of the SECTION module defining the composition of the fluid. The section name is searched from the connection points |
| VA16\_HEAT\_POINT\_NAME Name of generated heat point | - | shows the name of the created HEAT\_POINT module. A HEAT\_TRANS module can be connected to the heat point to describe the heat transfer from the outer surface of the valve wall |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Table 3. Attributes, default values, input/output-types and use in Flow models 2...6* | | | | | |
| **ATTRIBUTE** **Property name** | **Default value** | **Input / Output** | **Flow model (accuracy level L2...L6)** | | |
| **L2** | **L5** | **L6** |
| VA16\_CONNECT\_POINT\_1 Name of inlet connection point | - | I | x | x | x |
| VA16\_CONNECT\_POINT\_2 Name of outlet connection point | - | I | x | x | x |
| VA16\_AREA\_GIVEN Is diameter or area given as input | 2 | I | x | x | x |
| VA16\_OUTSIDE\_DIAM Outside diameter of valve | 100 | I or O | x | x | x |
| VA16\_INSIDE\_DIAM Inside diameter of valve | 100 | I or O | x | x | x |
| VA16\_AREA Flow area | 0.01 | I or O | x | x | x |
| VA16\_LENGTH Flow length of valve | 1 | I | x | x | x |
| VA16\_VALVE\_TYPE Valve type | 1 | I | x | x | x |
| VA16\_OPENING\_PRESSURE Opening pressure | 15 | I or O | x | x | x |
| VA16\_CLOSING\_PRESSURE Closing pressure | 10 | I or O | x | x | x |
| VA16\_CAPACITY\_MAX Maximum mass flow through the valve | 100 | I | x | x | x |
| VA16\_PRESSURE\_MAX Pressure corresponding maximum mass flow | 20 | I or O | x | x | x |
| VA16\_DENSITY\_AVE Density corresponding maximum mass flow | 1000 | I | x | x | x |
| VA16\_POPPING\_PRESSURE Pressure of popping point | 16 | I | x | x | x |
| VA16\_OPENING\_CURVE Opening curve | 0 | I | x | x | x |
| VA16\_CLOSING\_CURVE Closing curve | 0 | I | x | x | x |
| VA16\_CLOSED\_VALVE\_COEFF Loss coefficient of fully closed valve | 1010 | I | x | x | x |
| VA16\_ACCURACY\_LEVEL Flow model | 2 | I or O | x | x | x |
| VA16\_MIX\_MASS\_FLOW Mass flow | 0 | Note: | I | O | O |
| VA16\_LIQ\_MASS\_FLOW Liquid mass flow | 0 | Note: | O | I | I |
| VA16\_GAS\_MASS\_FLOW Gas mass flow | 0 | Note: | O | I | I |
| VA16\_DISCHARGE\_COEFF Discharge coefficient | 0.75 | I | x |  | x |
| VA16\_RELAX\_COEFF Relaxation coefficient of mass flow | 1 | I | x | x | x |
| VA16\_RELAX\_COEFF\_PRES Relaxation coefficient of inlet pressure | 0.1 | I | x | x | x |
| VA16\_DROPLET\_FRACTION Droplet fraction | 0.2 | I | x | x | x |
| VA16\_NONC\_GAS\_RATIO Air excess in flow | 0 | I | x |  | x |
| VA16\_PARALLEL\_CONNECTION Transfer of momentum over the valve | 0 | I | x |  | x |
| VA16\_AREA\_CHANGE\_TERM Is area change correction to momentum used | 0 | I | x |  | x |
| VA16\_EXPLICIT\_CONNECTION Explicit connection | 0 | I | x |  |  |
| VA16\_CONNECT\_EXPERIMENTS Connection between two experiments | 0 | I | x |  | x |
| VA16\_SPRAY\_CALC Spray calculation | 0 | I | x | x | x |
| VA16\_CRIT\_FLOW Is critical flow checked | 0 | I | x |  | x |
| VA16\_CLOSED\_VALVE\_CALC Treatment of a closed valve | 1 | I | x | x | x |
| VA16\_DRIVING\_TIME Driving time of valve | 0 | I | x | x | x |
| VA16\_MALFUNCTION Malfunction | 0 | I | x | x | x |
| VA16\_HS\_CREATED Is wall heat structure created | 0 | I | x | x | x |
| VA16\_HS\_THICKNESS\_1 Thickness of first layer in the wall | 0 | I | x | x | x |
| VA16\_HS\_THICKNESS\_2 Thickness of second layer in the wall | 0 | I | x | x | x |
| VA16\_HS\_THICKNESS\_3 Thickness of third layer in the wall | 0 | I | x | x | x |
| VA16\_HS\_MATERIAL\_1 Material number of first layer in the wall | 5 | I | x | x | x |
| VA16\_HS\_MATERIAL\_2 Material number of second layer in the wall | 5 | I | x | x | x |
| VA16\_HS\_MATERIAL\_3 Material number of third layer in the wall | 5 | I | x | x | x |
| VA16\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | 2 | I | x | x | x |
| VA16\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | 1 | I | x | x | x |
| VA16\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | 1 | I | x | x | x |
| VA16\_HEAT\_COND\_AXI Is axial heat conduction solved | 0 | I | x | x | x |
| VA16\_SPRAY\_MODULE Name of outlet spray module | - | I | x | x | x |
| VA16\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | I | x | x | x |
| VA16\_VOLUME Volume of valve | - | O | x | x | x |
| VA16\_VELOCITY Flow velocity | - | O | x | x | x |
| VA16\_LIQ\_VELOC Liquid velocity | - | O | x | x | x |
| VA16\_GAS\_VELOC Gas velocity | - | O | x | x | x |
| VA16\_MIX\_VOL\_FLOW Volumetric flow | - | O | x | x | x |
| VA16\_PRESSURE\_LOSS Pressure loss | - | O | x |  | x |
| VA16\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | - | O | x |  | x |
| VA16\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | - | O | x |  | x |
| VA16\_LOSS\_OTHER Other pressure losses | - | O | x |  | x |
| VA16\_POSITION Position of valve | - | O | x | x | x |
| VA16\_SECTION\_NAME Name of fluid | - | O | x | x | x |
| VA16\_HEAT\_POINT\_NAME Name of generated heat point | - | O | x | x | x |

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**Special**

Heat transfer is calculated between the heat structure and the connection points of the valve (unless the Flow model of a connection point is 0 or the valve is part of a combination module). The heat structure consists of one, two or three layers of different materials.  
If the Flow model of the outlet connection point is 0 or 4, the valve has the same Flow model as the inlet connection point. The following combinations of Flow models for the two connection points are allowed: 0-2, 2-0, 2-2, 2-4, 2-5, 2-6, 4-2, 4-5, 4-6, 5-2, 5-4, 5-5, 6-2, 6-4 and 6-6. If the valve is connected to the containment model, see more in [**Connection of thermal hydraulic and containment models**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/contref/th-cont_connection.pdf) (Note! Link valid only in Containment Apros version).

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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
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**CONTROL\_VALVE**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\C51F45D3.tmp | Control Valve |

**Contents**

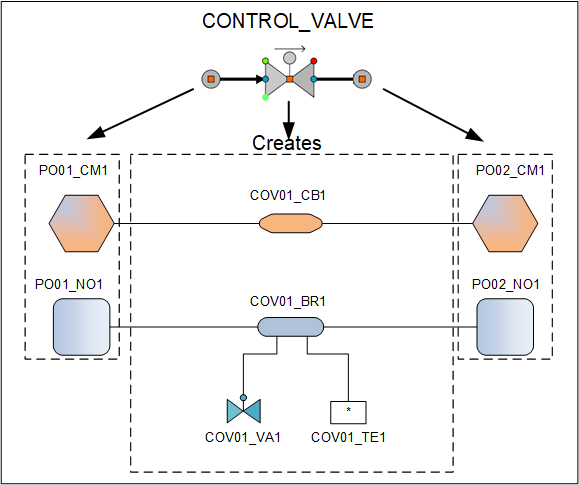
[**Introduction**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Control_valve.html#Introduction)  
[**Structure**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Control_valve.html#Structure)  
[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Control_valve.html#Attributes)  
[**Special**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Control_valve.html#Special)  
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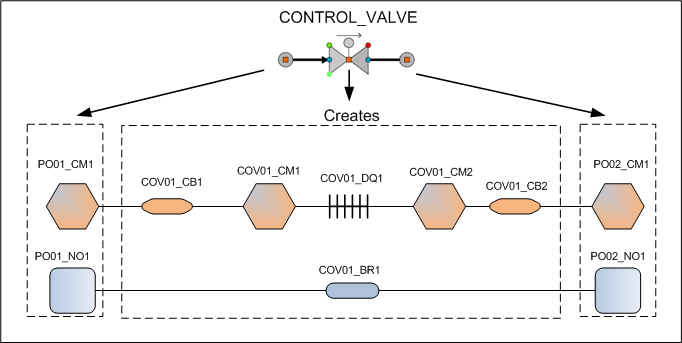
**Introduction**

CONTROL\_VALVE is a sophisticated valve component. The user specifies the flow resistance of the valve by means of mass flow, the pressure drop and the density. If desired, the system also creates the device controller for controlling the position of the valve and a heat structure representing the wall of the valve. The CONTROL\_VALVE module can be connected to the Flow models 0, 1 (one-phase model), 2 (homogeneous model), 4 (containment model), 5 (five-equation model) or 6 (six-equation model) and the Flow model of the valve is usually the same as the Flow model of the outlet connection point.

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**Structure**

*Figure 1. Calculation level structure of a simple CONTROL\_VALVE connection, Flow model 1-6*

*Figure 2. Calculation level structure of a simple CONTROL\_VALVE connection, Flow model 0*

[**List of symbols**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Module_type_documentation_format.html#List_of_symbols)

Consider a control valve connected to two points. The created structure is shown in Figure 1 and 2, depending on Flow model, and the relevant parameters for this kind of a calculation level structures are shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Relevant input parameters for a simple CONTROL\_VALVE* | | | |
| **Attribute Property name** | **Unit** | **Value** | **Note** |
| VA12\_LENGTH Flowlength of valve | m | 1 |  |
| VA12\_AREA\_GIVEN Is diameter or area given as input | - | 2 | The outside diameter and wall thickness are given as input parameters and the flow area is calculated from them |
| VA12\_OUTSIDE\_DIAM Outside diameter of valve | mm | 100 |  |
| VA12\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | 10 |  |
| VA12\_POSITION\_NOM Nominal position of valve | - | 1 |  |
| VA12\_MASS\_FLOW\_GIVEN Nominal mass flow | kg/s | 100 |  |
| VA12\_PRESSURE\_LOSS Nominal pressure loss | MPa | 0.1 |  |
| VA12\_DENSITY\_AVE Nominal density | kg/m3 | 1000 |  |

With Flow model 1-6, CONTROL\_VALVE creates two branches, one for thermal hydraulic calculation (COV01\_BR1) and the other for composition calculation (COV01\_CB1). Branches are connected to nodes of the inlet and outlet POINT modules. A calculation level control valve module (COV01\_VA1) is also created as well as a thermal control exception module (COV01\_TE1). Thermal control exception module allows the user to add exceptions to the general calculation parameters.The attributes of this module type are listed in [**TH\_CONTROL\_EXCEPTION**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/thermref/Th_control_exception.html).  
With Flow model 0, CONTROL\_VALVE creates one thermal hydraulic branch (COV01\_BR1), two compositions branches (COV01\_CB1, COV01\_CB2), two composition nodes (COV01\_CM1, COV01\_CM2) and one data queue module (COV01\_DQ1).

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**Attributes**

|  |  |  |
| --- | --- | --- |
| *Table 2. Attributes, units and descriptions* | | |
| **ATTRIBUTE** **Property name** | **Unit** | **Description** |
| VA12\_CONNECT\_POINT\_1 Name of inlet connection point | - | is the name of the first connection point |
| VA12\_CONNECT\_POINT\_2 Name of outlet connection point | - | is the name of the second connection point |
| VA12\_AREA\_GIVEN Is diameter or area given as input | - | If the value of the attribute is 2, the outside diameter and the thickness of the first layer of the valve wall are given as input values, the inside diameter is calculated from these values and the flow area is calculated from the inside diameter assuming a circular cross section. If the value of the attribute is 1, the flow area of the valve is given as an input value. If the value of the attribute is 0, the inside diameter is given as an input value and the flow area is calculated from the inside diameter assuming a circular cross section. |
| VA12\_OUTSIDE\_DIAM Outside diameter of valve | mm | is the outside diameter of the valve. If the value of the attribute VA12\_AREA\_GIVEN is 2, the outside diameter is given as an input value, the inside diameter is calculated from the outside diameter and the thickness of the first layer of the valve wall and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA12\_AREA\_GIVEN is 0 or 1, the outside diameter is calculated from the relevant input parameters. |
| VA12\_INSIDE\_DIAM Inside diameter of valve | mm | is the inside diameter of the valve. If the value of the attribute VA12\_AREA\_GIVEN is 0, the inside diameter is given as an input value and the flow area of the valve is calculated from the inside diameter assuming a circular cross section. If the value of the attribute VA12\_AREA\_GIVEN is 1 or 2, the inside diameter is calculated from the relevant input parameters assuming a circular cross section. |
| VA12\_AREA Flow area | m2 | is the flow area of the valve. If the value of the attribute VA12\_AREA\_GIVEN is 1, the area is given as an input value. If the value of the attribute VA12\_AREA\_GIVEN is 0 or 2, the area is calculated from the relevant input parameters assuming a circular cross section. |
| VA12\_LENGTH Flow length of valve | m | is the length of the valve |
| VA12\_MASS\_FLOW\_GIVEN Nominal mass flow | kg/s | is the mass flow of the valve at given point. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA12\_PRESSURE\_LOSS Nominal pressure loss | MPa | is the pressure loss of the valve at given point. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA12\_DENSITY\_AVE Nominal density | kg/m3 | is the average density of the flow corresponding to the mass flow and pressure loss mentioned above. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA12\_POSITION\_NOM Nominal position of valve | ­- | is the position of the valve in which point the mass flow, the pressure loss and the average density mentioned above have been given. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA12\_SPECIFIC\_CURVE Shape of specific curve | - | is the number of the specific curve of the valve. = 1 is a linear valve, = 2 is an equal percentage valve, = 3 the points of the specific curve are defined in the attribute VA12\_CONTROL\_CURVES. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0. |
| VA12\_CONTROL\_CURVES Position/mass flow-curve | -, kg/s | is the specific curve of the valve, if the user wants to give it himself. Up to 30 (valve position, mass flow)-points may be given. The valve positions in the given points have to be in increasing order. When the position between a pair of points is non-increasing, it signifies the end of the given points. If the position goes outside the given points during simulation, the mass flow of the first or last point is used. However, the user should define the curve so that it covers the whole range from the minimum position of the valve to the maximum position. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 0 and the value of the attribute VA12\_SPECIFIC\_CURVE is 3. |
| VA12\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | - | defines whether the Kv- or Cv-values of the valve are given. Possible values are: 0: not given 1: Kv-value for a fully open valve is given in the attribute VA12\_KV\_CV\_COEFF and the valve is assumed to be linear 2: Kv-value for a fully open valve is given in the attribute VA12\_KV\_CV\_COEFF and the valve is assumed to be equal percentual. 3: Kv-curve is given in the attribute VA12\_KV\_CV\_CURVES (Kv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. 101: Cv-value for a fully open valve is given in the attribute VA12\_KV\_CV\_COEFF and the valve is assumed to be linear 102: Cv-value for a fully open valve is given in the attribute VA12\_KV\_CV\_COEFF and the valve is assumed to be equal percentual. 103: Cv-curve is given in the attribute VA12\_KV\_CV\_CURVES (Cv-value as a function of valve position), maximum 30 pairs, valve position in ascending order. Notice! When this attribute has larger value than 0, it is assumed that in spite of the value of the attribute VA12\_SPECIFIC\_CURVE this attribute is dominant. |
| VA12\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | m3/h/bar\*\*1/2 (Kv) or US gal/min/psi\*\*1/2 (Cv) | is the Kv- or Cv-value of a fully open valve (volumetric flow). This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 1, 2, 101 or 102. |
| VA12\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | -,m3/h/bar\*\*1/2 (Kv) or -,US gal/min/psi\*\*1/2 (Cv) | Kv- or Cv-values as a function of valve position (position 0 … 1, valve capacity). Up to 30 point pairs may be given. The valve positions in the given points have to be in increasing order. This attribute is used if the value of the attribute VA12\_KV\_CV\_VALUE\_GIVEN is 3 or 103. For further information please look at the documentation of the [**CALC\_CONTROL\_VALVE**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/calcref/Calc_control_valve.html#VA_KV_CV_CURVES). |
| VA12\_SHUT\_TIME Driving time of valve | s | is the driving time of the valve |
| VA12\_ACCURACY\_LEVEL Flow model | ­- | is the accuracy level on which the valve is connected to the branch, it must be either 0, 1, 2, 5 or 6. The accuracy level has to be given only if a valve is added from the APROS command window. Otherwise the accuracy level is automatically searched from the connection points of the valve. |
| VA12\_MIX\_MASS\_FLOW Mass flow | kg/s | is the mass flow of the valve |
| VA12\_LIQ\_MASS\_FLOW Liquid mass flow | kg/s | is the liquid mass flow of the valve |
| VA12\_GAS\_MASS\_FLOW Gas mass flow | kg/s | is the gas mass flow of the valve |
| VA12\_DISCHARGE\_COEFF Discharge coefficient | - | defines the discharge coefficient. If the critical flow is checked in the valve, the critical flow given by the Moody model is multiplied by the discharge coefficient. The coefficient defines the ratio of the effective flow area in the break orifice and the total area of the orifice. The value of the coefficient should normally be between 0.6 (sharp-edged break orifice) and 1 (ideally smoothed orifice). |
| VA12\_RELAX\_COEFF Relaxation coefficient of mass flow | - | is the relaxation coefficient used in the calculation of the mass flow in the valve. The relaxation coefficient is used if the valve is defined between the homogeneous and five-equation models, between the homogeneous and six-equation models, between the homogeneous model and level 0 thermal hydraulics or between the homogeneous and containment models. If the value of the relaxation coefficient is e.g. 0.7, the new mass flow is 0.7 \* the mass flow calculated from the matrix coefficients of the pressure-flow solution + 0.3 \* the mass flow of the previous time step. If the relaxation coefficient is 1, there is no relaxation. The coefficient has to be > 0 and <= 1. The use of the relaxation coefficient makes the changes of mass flow slower but may make the solution more stable. |
| VA12\_DROPLET\_FRACTION Droplet fraction | - | is the fraction of liquid flow of the valve going into droplets in the connected containment model node (the rest of the liquid flow goes to the liquid pool). The fraction is used if the elevation of the valve is above the liquid level of the containment model node. |
| VA12\_NONC\_GAS\_RATIO Air excess in flow | - | defines how much more noncondensable gas (air) compared to the average air mass fraction is transferred with the flow in the valve. The value 0 means that the air mass fraction of the valve is the same as the air mass fraction of the upwind node (calculated in the gas phase). The variable VA12NR is used in the calculation as follows: the used air fraction Xair = (1 + VA12NR) Xair,up where Xair,up is the air mass fraction of the upwind node. Negative values (-1 < VA12NR < 0) can also be used and then the flow includes less air than the upwind air fraction indicates. The calculated air mass fraction is limited between 0 and 1. The attribute is used when the accuracy level of the input and output points of the valve is 2 or 6 (when the accuracy level is 2, the WG or EP section has to be selected in the points). The attribute is used only when the mass flow of the valve is positive. |
| VA12\_PARALLEL\_CONNECTION Transfer of momentum over the valve | - | The value 0 means that momentum is not transferred over the valve. The values 1 and 2 mean that momentum is transferred over the valve. The difference between values 1 and 2 is the way how momentum is divided between parallel calculation level branches. The value 1 means that the whole momentum flow coming into a node (the sum of momentum flows of branches transferring momentum and flowing towards the node) is divided between the branches going out of the node and transferring momentum. The value 2 means that the incoming momentum flow multiplied by the sum of the mass flows in the branches going out of the node and transferring momentum and divided by the sum of all mass flows going out of the node is divided between the branches going out of the node and transferring momentum. |
| VA12\_AREA\_CHANGE\_TERM Is area change correction to  momentum used | - | defines whether a correction term due to flow area change is calculated in the momentum equation (value 1) or not (value 0). The area change term is calculated if VA12\_AREA\_CHANGE\_TERM = 1 and VA12\_PARALLEL\_CONNECTION = 1 or 2. |
| VA12\_EXPLICIT\_CONNECTION Explicit connection | - | defines whether the branch created by the valve takes part implicitly or explicitly in the pressure solution. The value 0 means that the branch takes part implicitly, 1 means that the contribution to the first connection point is explicit and 2 that the contribution to the second connection point is explicit. An explicit connection is recommended to be used only if the mass flow in the valve is small compared to the mass of the connection point to which the connection is explicit. |
| VA12\_CONNECT\_EXPERIMENTS Connection between two experiments | - | defines whether the valve connects two experiments defining two separately solved processes in multi-processor simulation (value 1 or 2) or not (value 0). If the value of the attribute is 1 or 2, the valve creates one branch where flow is solved, one external branch and two external nodes. The external modules define boundary conditions for the two processes and their state is updated from the branch in solution and the connection points of the valve. If the value of the attribute is 1, the external branch is connected to the second connection point. The value 2 means that the external branch is connected to the first connection point. |
| VA12\_WALL\_FRICTION\_CORR Wall friction correlation | - | specifies the number of the correlation used for the calculation of the wall friction coefficient of the created branch of the homogeneous model. The value 1 means that the default correlation based on the roughness (modified Colebrook equation) is used. The value 3 means that the Prandtl friction law is used. The Prandtl law is independent of the branch roughness and usually gives smaller friction coefficients than the default correlation. Number 2 is reserved for later use. Numbers greater than 999 are reserved for user-written correlations.  A negative value means that the correlation is selected with the attributes of the TH\_CONTROL and TH\_CONTROL\_EXCEPTION modules. |
| VA12\_SPRAY\_CALC Spray calculation | - | defines whether the liquid flow of the valve is used as input for the spray calculation of the containment model (value 1) or not (value 0). The attribute is used only if the valve is connected to a containment model node (one of the connection points is either a point of accuracy level 4 or a containment model node (module type CN1\_NODE)). |
| VA12\_POSITION Position set point of valve | - | is the input position of the valve (position set point) |
| VA12\_CRIT\_FLOW Is critical flow checked | - | is 1, if the flow in the valve is restricted to the critical flow (otherwise 0) |
| VA12\_CLOSED\_VALVE\_CALC Treatment of a closed valve | - | defines the calculation for a completely closed valve. The value 1 means that the flow through a closed valve is set to 0. The value 2 means that a small flow goes through a closed valve. The value 2 is recommended if the closing of the valve forms an isolated subsystem where the flow in all nodes has been defined as uncompressible. If the accuracy level of both connection points is 5, the flow through a closed valve is never set to 0. |
| VA12\_LEAK\_POSITION Leak position for flow through a closed valve | - | defines the valve position used in the calculation of the loss coefficient for a fully closed valve. The value can be used to tune the flow through a closed valve and it has an effect, if VA12\_CLOSED\_VALVE\_CALC = 2. |
| VA12\_MALFUNCTION Malfunction | - | defines a malfunction (fault) in the valve. = 0: no malfunction, = 1: the valve is stuck, = 2: the valve is opened, = 3: the valve is closed. If a malfunction is defined, the effect of automation and electrical systems on the valve calculation is ignored. Note! If CONTROL\_VALVE is connected to Actuator it will override all local controls including the functionality of this MALFUNCTION attribute. |
| VA12\_AUTOM\_CREATED Is device controller created | - | is TRUE, if a device controller is created |
| VA12\_HS\_CREATED Is wall heat structure created | - | If the value 1 is given, a heat structure representing the wall of the valve is created. |
| VA12\_HS\_THICKNESS\_1 Thickness of first layer in the wall | mm | is the thickness of the first layer in the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1 and VA12\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA12\_HS\_THICKNESS\_2 Thickness of second layer in the wall | mm | is the thickness of the second layer in the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1, VA12\_HS\_NUMBER\_RAD\_1, VA12\_HS\_THICKNESS\_2 and VA12\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA12\_HS\_THICKNESS\_3 Thickness of third layer in the wall | mm | is the thickness of the third layer in the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1, VA12\_HS\_NUMBER\_RAD\_1, VA12\_HS\_THICKNESS\_3 and VA12\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA12\_HS\_MATERIAL\_1 Material number of first layer in the wall | - | is the number defining the material of the first layer of the heat structure representing the wall of the valve (see [**HSM\_MATERIAL**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/heatref/Hsm_material.html#Predefined_materials) for the possible values) |
| VA12\_HS\_MATERIAL\_2 Material number of second layer in the wall | - | is the number defining the material of the second layer of the heat structure representing the wall of the valve |
| VA12\_HS\_MATERIAL\_3 Material number of third layer in the wall | - | is the number defining the material of the third layer of the heat structure representing the wall of the valve |
| VA12\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | - | is the number of heat structure nodes in the radial direction in the first layer of the heat structure representing the wall of the valve. The first layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1 and VA12\_HS\_NUMBER\_RAD\_1 are > 0. |
| VA12\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | - | is the number of heat structure nodes in the radial direction in the second layer of the heat structure representing the wall of the valve. The second layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1, VA12\_HS\_NUMBER\_RAD\_1, VA12\_HS\_THICKNESS\_2 and VA12\_HS\_NUMBER\_RAD\_2 are > 0. |
| VA12\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | - | is the number of heat structure nodes in the radial direction in the third layer of the heat structure representing the wall of the valve. The third layer is generated, if the values of the attributes VA12\_HS\_CREATED, VA12\_HS\_THICKNESS\_1, VA12\_HS\_NUMBER\_RAD\_1, VA12\_HS\_THICKNESS\_3 and VA12\_HS\_NUMBER\_RAD\_3 are > 0. |
| VA12\_HEAT\_COND\_AXI Is axial heat conduction solved | - | defines whether axial heat conduction is calculated on the wall of the valve (value 1) or not (value 0) |
| VA12\_SPRAY\_MODULE Name of outlet spray module | - | defines the name of the internal spray module where the flow of the valve is transferred if the valve is a spray valve (the value of the attribute VA12\_SPRAY\_CALC is 1). If no spray module name is given, the spray module connected to the input or output node of the valve (a node of the containment model) is automatically searched. If more than one spray modules are connected to the node, the user has to define the correct spray module using this attribute. The module type of the spray module must be CNI\_SPRAY. |
| VA12\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | defines the name of the containment model node where the concentrations (e.g. the boron concentration) are transferred if the valve is a spray valve (the value of the attribute VA12\_SPRAY\_CALC is 1). If no name is given or the valve is not a spray valve, the input or output node of the valve (a node of the containment model) is automatically used if a sump is connected to the node. If no sump is connected to the node, the node connected to the drain water sump of the input or output node of the valve is searched. The name of the outlet node for spray concentrations should be defined, if no sump is connected to the node where the spray flow goes. The module type of the node must be CN1\_NODE. |
| VA12\_BUSBAR\_NAME Name of busbar to supply electricity | - | is the name of the busbar (ES\_NODE module) which the valve is connected to |
| VA12\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | defines the name of a binary signal indicating whether the valve has electricity (signal value TRUE) or not (value FALSE). The binary signal value is used if no busbar name is given in the attribute VA12\_BUSBAR\_NAME. If the busbar and binary signal names are not defined, it is assumed that the valve has electricity. |
| VA12\_EXTERNAL\_ACTION Valve behaviour when external power is lost | - | is the type of the action if the external power is lost. = 1: valve position remains unchanged, = 2: the valve will close, = 3 the valve will open |
| VA12\_VOLUME Volume of valve | m3 | shows the volume of the valve (= flow area ∙ length) |
| VA12\_VELOCITY Flow velocity | m/s | shows the flow velocity of the valve |
| VA12\_LIQ\_VELOC Flow velocity | m/s | shows the velocity of the liquid phase |
| VA12\_GAS\_VELOC Gas velocity | m/s | shows the velocity of the gas phase |
| VA12\_MIX\_VOL\_FLOW Volumetric flow | m3/s | shows the volumetric flow of the valve |
| VA12\_PRESSURE\_LOSS\_TOTAL Pressure loss | MPa | shows the total pressure loss over the valve consisting of wall friction, friction caused by the form loss coefficient and the valve loss coefficient and irreversible losses due to change of flow area and change of momentum flux between successive branches. The pressure loss is: the total pressure at the valve inlet - the total pressure at the valve outlet - the hydrostatic pressure difference of the valve. If the valve is connected to a combination module, the attribute shows the total pressure loss of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. If the mass flow of the valve is positive, the total pressure at the valve inlet is the total pressure of the input point. If the mass flow is negative, the total pressure at the valve inlet is: the static pressure of the input point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. If the mass flow of the valve is negative, the total pressure at the valve outlet is the total pressure of the output point. If the mass flow is positive, the total pressure at the valve outlet is: the static pressure of the output point + the dynamic pressure of the valve (½ \* density \* flow velocity2). If the valve does not transfer momentum, the dynamic pressure of the valve is 0. |
| VA12\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | MPa | shows the pressure loss over the valve caused by wall friction. If the valve is connected to a combination module, the attribute shows the total pressure loss due to wall friction of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA12\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | MPa | shows the pressure loss over the valve caused by the valve loss coefficient. If the valve is connected to a combination module, the attribute shows the total pressure loss due to form loss coefficients, valve loss coefficients and pump loss coefficients of all process components connected to the combination. The pressure loss is updated if the accuracy levels of the connection points are either 2 or 6. |
| VA12\_LOSS\_OTHER Other pressure losses | MPa | shows the irreversible pressure loss over the valve due to the change of flow area and the change of momentum flux between successive branches. If e.g. the value of the attribute VA12\_PARALLEL\_CONNECTION is 0 and 2 (or 1) in successive valves, a considerable pressure loss may occur in the latter valve because the flow is assumed to accelerate from 0. The pressure loss is updated if the accuracy level of both connection points is either 2 or 6. |
| VA12\_MEASURED\_POSITION Position of valve | - | shows the position of the valve |
| VA12\_CONTROLLED Is valve position controlled | - | has the value TRUE, if the position of the valve is controlled by an actuator or a device controller. Otherwise the value of the attribute is FALSE. |
| VA12\_SECTION\_NAME Name of fluid | - | shows the name of the SECTION module defining the composition of the fluid. The section name is searched from the connection points |
| VA12\_HEAT\_POINT\_NAME Name of generated heat point | - | shows the name of the created HEAT\_POINT module. A HEAT\_TRANS module can be connected to the heat point to describe the heat transfer from the outer surface of the valve wall |
| VA12\_POSIT\_MEASURE\_NAME Name of created position measurement module | - | shows the name of the position measurement |
| VA12\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | shows the names of the binary signals created by the valve |
| VA12\_ANALOG\_SIGNAL\_NAME Name of created analog signal | - | shows the name of the analog signal created by the valve |
| VA12\_PLUG\_FLOW\_USED Is plug flow | - | defines whether the valve uses the concentration plug flow solver (CPFS). Not implemented. |
| VA12\_MIN\_MASS\_FLOW Minimum mass flow | kg/s | defines the minimum mass flow though the valve ie. mass flow when POSITION = 0.0 |
| VA12\_MAX\_MASS\_FLOW Maximum mass flow | kg/s | defines the maximum mass flow though the valve ie. mass flow when POSITION = 1.0 |
| VA12\_CM1\_ADDRESSES | - | shows the database addresses of the input and output points' composition modules' data arrays |
| VA12\_TH0\_SIM\_ORDER\_NUM Simulation order (TH-level 0) | - | defines the simulation order when using accuracy level 0 |
| VA12\_NEG\_FLOW\_ALLOWED Is negative mass flow allowed in TH0 | - | defines whether negative mass flow is allowed in the valve when using accuracy level 0 |
| VA12\_DATA\_QUEUE\_NUMBER | - | shows the module number of the data\_queue module generated |
| VA12\_BRANCH\_NUMBER | - | shows the module number of the branch module generated |
| VA12\_NUMBER\_OF\_BLOCKS\_GI Is the number of data\_blocks given | - | defines whether the number of plug flow discretizations is user given or automatically calculated |
| VA12\_NUMBER\_OF\_BLOCKS The number of data\_blocks | - | is the number of discretizations used in the valve. This is either user given or calculated by the valve. The number of discretizations (data blocks) is calculated during the generation phase of the of the valve in the same manner as with the [**PIPE**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/Pipe.html#PI12_NUM_OF_DATA_BLOCKS) module. |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Table 3. Attributes, default values, input/output-types, use in Flow models 0...6* | | | | | | | |
| **ATTRIBUTE** **Property name** | **Default value** | **Input / Output** | **Flow model (accuracy level L0...L6)** | | | | |
| **L0** | **L1** | **L2** | **L5** | **L6** |
| VA12\_CONNECT\_POINT\_1 Name of inlet connection point | - | I | x | x | x | x | x |
| VA12\_CONNECT\_POINT\_2 Name of outlet connection point | - | I | x | x | x | x | x |
| VA12\_AREA\_GIVEN Is diameter or area given as input | 2 | I | x | x | x | x | x |
| VA12\_OUTSIDE\_DIAM Outside diameter of valve | 100 | I or O | x | x | x | x | x |
| VA12\_INSIDE\_DIAM Inside diameter of valve | 100 | I or O | x | x | x | x | x |
| VA12\_AREA Flow area | 0.01 | I or O | x | x | x | x | x |
| VA12\_LENGTH Flow length of valve | 1 | I | x | x | x | x | x |
| VA12\_MASS\_FLOW\_GIVEN Nominal mass flow | 100 | I | x | x | x | x | x |
| VA12\_PRESSURE\_LOSS Nominal pressure loss | 0.1 | I |  | x | x | x | x |
| VA12\_DENSITY\_AVE Nominal density | 1000 | I | x | x | x | x | x |
| VA12\_POSITION\_NOM Nominal position of valve | 1 | I | x | x | x | x | x |
| VA12\_SPECIFIC\_CURVE Shape of specific curve | 1 | I |  | x | x | x | x |
| VA12\_CONTROL\_CURVES Position/mass flow-curve | 0 | I |  | x | x | x | x |
| VA12\_KV\_CV\_VALUE\_GIVEN Kv- or Cv-value or -curve given | 0 | I |  | x | x | x | x |
| VA12\_KV\_CV\_COEFF Given Kv- or Cv-coefficient | 360 | I |  | x | x | x | x |
| VA12\_KV\_CV\_CURVES Position/capacity Kv- or Cv-curve | 0 | I |  | x | x | x | x |
| VA12\_SHUT\_TIME Driving time of valve | 30 | I |  | x | x | x | x |
| VA12\_ACCURACY\_LEVEL Flow model | 2 | I or O | x | x | x | x | x |
| VA12\_MIX\_MASS\_FLOW Mass flow | 0 | Note: | O | I | I | O | O |
| VA12\_LIQ\_MASS\_FLOW Liquid mass flow | 0 | Note: | O | O | O | I | I |
| VA12\_GAS\_MASS\_FLOW Gas mass flow | 0 | Note: | O | O | O | I | I |
| VA12\_DISCHARGE\_COEFF Discharge coefficient | 0.75 | I |  |  | x |  | x |
| VA12\_RELAX\_COEFF Relaxation coefficient of mass flow | 1 | I |  |  | x | x | x |
| VA12\_DROPLET\_FRACTION Droplet fraction | 0.2 | I |  |  | x | x | x |
| VA12\_NONC\_GAS\_RATIO Air excess in flow | 0 | I |  |  | x |  | x |
| VA12\_PARALLEL\_CONNECTION Transfer of momentum over the valve | 0 | I |  |  | x |  | x |
| VA12\_AREA\_CHANGE\_TERM Is area change correction to  momentum used | 0 | I |  |  | x |  | x |
| VA12\_EXPLICIT\_CONNECTION Explicit connection | 0 | I |  |  | x |  |  |
| VA12\_CONNECT\_EXPERIMENTS Connection between two experiments | 0 | I |  |  | x |  | x |
| VA12\_WALL\_FRICTION\_CORR Wall friction correlation | -1000 | I |  |  | x |  |  |
| VA12\_SPRAY\_CALC Spray calculation | 0 | I |  |  | x | x | x |
| VA12\_POSITION Position set point of valve | 1 | I | x | x | x | x | x |
| VA12\_CRIT\_FLOW Is critical flow checked | 0 | I |  |  | x |  | x |
| VA12\_CLOSED\_VALVE\_CALC Treatment of a closed valve | 1 | I |  | x | x | x | x |
| VA12\_LEAK\_POSITION Leak position for flow through a closed valve | 0 | I |  | x | x | x | x |
| VA12\_MALFUNCTION Malfunction | 0 | I |  | x | x | x | x |
| VA12\_AUTOM\_CREATED Is device controller created | FALSE | I |  | x | x | x | x |
| VA12\_HS\_CREATED Is wall heat structure created | 0 | I |  | x | x | x | x |
| VA12\_HS\_THICKNESS\_1 Thickness of first layer in the wall | 0 | I |  | x | x | x | x |
| VA12\_HS\_THICKNESS\_2 Thickness of second layer in the wall | 0 | I |  | x | x | x | x |
| VA12\_HS\_THICKNESS\_3 Thickness of third layer in the wall | 0 | I |  | x | x | x | x |
| VA12\_HS\_MATERIAL\_1 Material number of first layer in the wall | 5 | I |  | x | x | x | x |
| VA12\_HS\_MATERIAL\_2 Material number of second layer in the wall | 5 | I |  | x | x | x | x |
| VA12\_HS\_MATERIAL\_3 Material number of third layer in the wall | 5 | I |  | x | x | x | x |
| VA12\_HS\_NUMBER\_RAD\_1 Number of nodes in first layer of the wall | 2 | I |  | x | x | x | x |
| VA12\_HS\_NUMBER\_RAD\_2 Number of nodes in second layer of the wall | 1 | I |  | x | x | x | x |
| VA12\_HS\_NUMBER\_RAD\_3 Number of nodes in third layer of the wall | 1 | I |  | x | x | x | x |
| VA12\_HEAT\_COND\_AXI Is axial heat conduction solved | 0 | I |  | x | x | x | x |
| VA12\_SPRAY\_MODULE Name of outlet spray module | - | I |  |  | x | x | x |
| VA12\_SPRAY\_CONC\_NODE Name of outlet node for spray concentrations | - | I |  |  | x | x | x |
| VA12\_BUSBAR\_NAME Name of busbar to supply electricity | - | I |  | x | x | x | x |
| VA12\_ELEC\_SIGNAM Name of electric supply BIN SIGNAL | - | I |  | x | x | x | x |
| VA12\_EXTERNAL\_ACTION Valve behaviour when external power is lost | 1 | I |  | x | x | x | x |
| VA12\_VOLUME Volume of valve | - | O | x | x | x | x | x |
| VA12\_VELOCITY Flow velocity | - | O | x | x | x | x | x |
| VA12\_LIQ\_VELOC Flow velocity | - | O | x | x | x | x | x |
| VA12\_GAS\_VELOC Gas velocity | - | O | x | x | x | x | x |
| VA12\_MIX\_VOL\_FLOW Volumetric flow | - | O | x | x | x | x | x |
| VA12\_PRESSURE\_LOSS\_TOTAL Pressure loss | - | O |  |  | x |  | x |
| VA12\_LOSS\_WALL\_FRICT Pressure loss due to wall friction | - | O |  |  | x |  | x |
| VA12\_LOSS\_LOSS\_COEFF Pressure loss due to loss coefficient | - | O |  |  | x |  | x |
| VA12\_LOSS\_OTHER Other pressure losses | - | O |  |  | x |  | x |
| VA12\_MEASURED\_POSITION Position of valve | - | O | x | x | x | x | x |
| VA12\_CONTROLLED Is valve position controlled | - | O | x | x | x | x | x |
| VA12\_SECTION\_NAME Name of fluid | - | O | x | x | x | x | x |
| VA12\_HEAT\_POINT\_NAME Name of generated heat point | - | O |  | x | x | x | x |
| VA12\_POSIT\_MEASURE\_NAME Name of created position measurement module | - | O |  | x | x | x | x |
| VA12\_BINARY\_SIGNAL\_NAME Name of created binary signal | - | O |  | x | x | x | x |
| VA12\_ANALOG\_SIGNAL\_NAME Name of created analog signal | - | O |  | x | x | x | x |
| VA12\_PLUG\_FLOW\_USED Is plug flow | FALSE | I |  |  |  |  |  |
| VA12\_MIN\_MASS\_FLOW Minimum mass flow | 0 | I | x |  |  |  |  |
| VA12\_MAX\_MASS\_FLOW Maximum mass flow | 100.0 | I | x |  |  |  |  |
| VA12\_CM1\_ADDRESSES | - | O | x |  |  |  |  |
| VA12\_TH0\_SIM\_ORDER\_NUM Simulation order (TH-level 0) | 300 | I | x |  |  |  |  |
| VA12\_NEG\_FLOW\_ALLOWED Is negative mass flow allowed in TH0 | FALSE | I | x |  |  |  |  |
| VA12\_DATA\_QUEUE\_NUMBER | - | O | x |  |  |  |  |
| VA12\_BRANCH\_NUMBER | - | O | x |  |  |  |  |
| VA12\_NUMBER\_OF\_BLOCKS\_GI Is the number of data\_blocks given | FALSE | I | x |  |  |  |  |
| VA12\_NUMBER\_OF\_BLOCKS The number of data\_blocks | - | I / O | x |  |  |  |  |

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**Special**

Heat transfer is calculated between the heat structure and the connection points of the valve (unless the Flow model of a connection point is 0 or 1 or the valve is part of a COMBINATION module). The heat structure consists of one, two or three layers of different materials.  
If the Flow model of the outlet connection point is 0 or 4, the valve has the same Flow model as the inlet connection point. The following combinations of Flow models for the two connection points are allowed:  0-0, 0-1, 0-2, 1-0, 1-1, 1-2, 1-5, 1-6, 2-0, 2-1, 2-2, 2-4, 2-5, 2-6, 4-2, 4-5, 4-6, 5-1, 5-2, 5-4, 5-5, 6-1, 6-2, 6-4 and 6-6. If the valve is connected to the containment model, see more in [**Connection of thermal hydraulic and containment models**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/contref/th-cont_connection.pdf) (Note! Link valid only in Containment Apros version).

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[**Valves**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/procref/pcvalv.html)  
[**Main Table of Contents**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/index.htm)

**DEVICE\_CONTROL\_ONOFF\_FB**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\4D67A98B.tmp | DC On/Off Feedback (ON/OFF Device Control, with feedback) |

**Contents**

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[**Attributes**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Device_control_onoff_fb.html#Attributes)  
[**General information**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Device_control_onoff_fb.html#General_information)  
[**Actuators and Device controllers**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/auact.html)  
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**Introduction**

This device controller type (DC4) can be used as an interface from logic circuits to the on/off process devices the actual state of which is possible to get as an feedback information. This module is typically used with pumps, fans or mills (see [**Table 4.1**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/guides/autgui/autgui.htm#Attributes) in Building Guide).

A flow chart description of the DEVICE\_CONTROL\_ONOFF\_FB module can be found in the following figures.

[**Fig. 1**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/images/DC4_FC_1.gif), [**Fig. 2**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/images/DC4_FC_2.gif) and [**Fig. 3**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/images/DC4_FC_3.gif).

Information how to connect device control modules with process components can be found in the Building Guide, see [**"Using Device Controllers"**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/guides/autgui/autgui.htm#Using_Device_Controllers).

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**Attributes**

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Attributes, types, default values and descriptions* | | | |
| **ATTRIBUTE** **Property name** | **Type** | **Default value** | **Description** |
| DC4\_PROTECTION\_0 Protection stop | LO | F | Logical value, protection input for stop command |
| DC4\_PROTECTION\_1 Protection start | LO | F | Logical value, protection input for start command |
| DC4\_ENABLE\_0 Enable stop | LO | T | Logical value, enable for manual and automatic stop commands |
| DC4\_ENABLE\_1 Enable start | LO | T | Logical value, enable for manual and automatic start commands |
| DC4\_MANUAL\_0 MAN stop command | LO | F | Manual stop command, see also DC4\_CONTROL\_STATE. The value is automatically reset after TRUE state has been handled |
| DC4\_MANUAL\_1 MAN start command | LO | F | Manual start command, see also dc4\_control\_state. The value is automatically reset after TRUE state has been handled |
| DC4\_AUTO\_0 AUTO stop command | LO | F | Stop command from some logic circuit, see also dc4\_control\_state. |
| DC4\_AUTO\_1 AUTO start command | LO | F | Start command from some logic circuit, see also dc4\_control\_state. |
| DC4\_ELECTRIC\_SUPPLY Electricity supplied? | LO | T | Is electricity supplied for the device controller ? |
| DC4\_LOCAL\_0 Local stop command | LO | F | Local stop command, see also dc4\_control\_state. The value is automatically reset after TRUE state has been handled |
| DC4\_LOCAL\_1 Local start command | LO | F | Local start command, see also dc4\_control\_state. The value is automatically reset after TRUE state has been handled |
| DC4\_CONTROL\_TIME Control time | RE | 0.0 | Control time of the device (in seconds), an alarm is given if the device has not started during this time from the given START command |
| DC4\_CONTROL\_STATE Control State: gen/AUTO/MAN/local | IN | 0 | 0 = General state: both AUTO and MAN commands work.. 1 = AUTO state: only AUTO commands (e.g. dc4\_auto\_0) work. 2 = MAN state: only MAN commands (e.g. dc4\_manual\_0) work. 3 = LOCAL state: the device is controlled by LOCAL commands: dc4\_local\_0 and dc4\_local\_1 |
| DC4\_PROTECTION\_0\_S | ON\* | NULL | Signal input for attribute 'dc4\_protection\_0' |
| DC4\_PROTECTION\_1\_S | ON\* | NULL | Signal input for attribute 'dc4\_protection\_1' |
| DC4\_ENABLE\_0\_S | ON\* | NULL | Signal input for attribute 'dc4\_enable\_0' |
| DC4\_ENABLE\_1\_S | ON\* | NULL | Signal input for attribute 'dc4\_enable\_1' |
| DC4\_AUTO\_0\_S | ON\* | NULL | Signal input for attribute 'dc4\_auto\_0' |
| DC4\_AUTO\_1\_S | ON\* | NULL | Signal input for attribute 'dc4\_auto\_1' |
| DC4\_ELECTRIC\_SUPPLY\_S | ON\* | NULL | Signal input for attribute 'dc4\_electric\_supply' |
| DC4\_STATE\_SIGN | ON | \* | Binary output signal name, signal indicates which is the last command (stop or start) that has been given to the device |
| DC4\_OFF\_COMMAND | OP | NULL NULL | Object pair defining the entity to which the off command is connected (module name and attribute name) |
| DC4\_ON\_COMMAND | OP | NULL NULL | Object pair defining the entity to which the on command is connected (module name and attribute name) |
| DC4\_STATE\_OF\_DEVICE | OP | NULL NULL | Object pair defining the feedback from the controlled device. The attribute defined by the Object pair should be True when device is running and False when device is not running |
| DC4\_NOT\_ABLE\_START\_SIGN | ON | \* | Disturbance signal name, signal will be TRUE if the device has not been started during the defined control time after the given START command |
| DC4\_DISTURBANCE\_SIGN | ON | \* | Disturbance signal name, signal will be TRUE if the device has been stopped without a given STOP command (either manual or from logic circuit) |
| DC4\_NOT\_ABLE\_START\_IND | LO | F | Signal indicating that device has not been started after START command. |
| DC4\_DISTURBANCE\_IND | LO | F | Signal indicating that device has been stopped without STOP command. |
| DC4\_IN\_CYCLE | IN | 0 | Indicator bit that tells whether the module belongs to a CYCLE (=1) or not (=0), set automatically. |

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**General information**

The interface to the process device is defined by two object pair attributes (on\_command, off\_command) and the feedback from the state of the device is defined in attribute state\_of\_device (also object pair attribute). The output signal 'state\_sign' can be used as a inside memory output of the module. The state of it tells what has been the latest command from the device\_controller. The process device can be controlled through three different channels, the protection system, the logic circuits and manual commands have their own inputs.

The protection channels are prioritized over the other channels and OFF commands are prioritized over the ON commands.

The manual and logic circuit inputs have common enable inputs, separately for ON and OFF commands. If either of these enable inputs are in 'False' state, the corresponding commands are then disabled. The protection inputs do not have any enable signals.

The output commands from the component will stay in 'True' state until the state feedback from the process device will reset them. Only one of the output commands can be in 'True' state at the same time. Normally both output commands are in 'False' state. They are in 'True' state only when the device controller wants to change the state of the process devices.

If the manually or automatically given START command has not changed the process device to ON state during a defined control\_time, the alarm signal 'Not able to start' will get 'True' value.

If the process device has been successfully started, either manually or automatically, and then the device stops without manually or automatically given STOP command, an alarm signal 'Disturbance' will get 'True' value ('Device has tripped'). After the trip it is not possible to start up the device before the disturbance has been quit by giving the STOP command to the device controller. This STOP command will also reset the 'Not able to start' signal, if it was in TRUE state.

Manual inputs are considered as pulses, so they will be automatically reset after they have been handled.

If the electric supply of the device controller fails, the output signals of the device controller will get 'False' state. So the pump for example will not necessarily stop, but continues running if it was already running earlier. It is not possible to stop the pump through the device controller, if there is no electric supply for the device controller.

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[**Actuators and Device controllers**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/auact.html)  
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**PRESSURE\_MEASUREMENT**

|  |  |
| --- | --- |
| **Symbol** | **User interface name** |
| C:\Users\moshiur\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\210E7BCE.tmp | Pressure (Pressure Measurement) |

**Contents**

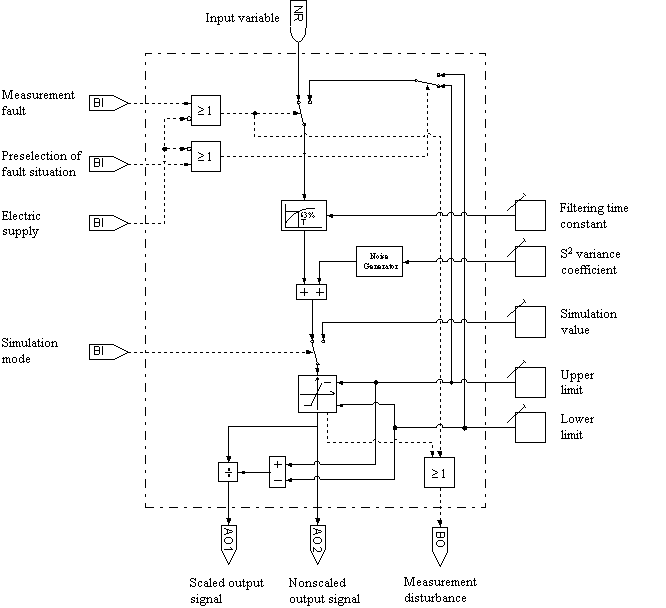
**[Introduction](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Pressure_measurement.html" \l "Introduction)**  
**[Structure](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Pressure_measurement.html" \l "Structure)**  
**[Attributes](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Pressure_measurement.html" \l "Attributes)**  
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**Introduction**

The PRESSURE\_MEASUREMENT module can be used to measure the pressure from different process components (points, tanks, headers, channels, etc).

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**Structure**



*Figure 1. Logic behind the PRESSURE\_MEASUREMENT*

Consider a PRESSURE\_MEASUREMENT module connected in an automation model. The created structure is shown in Figure 1 and the relevant parameters in a simple case for this kind of a logical structure are shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 1. Relevant parameters for a simple PRESSURE\_MEASUREMENT* | | | |
| **Attribute Property name** | **Type** | **Value** | **Note** |
| PM\_UNIT Unit of output value | CH | UserDefined | Select the unit from the drop down menu |
| PM\_COEFFICIENT Scale coefficient | DO | 1.0 |  |
| PM\_BIAS Scale bias | DO | 0.2 |  |
| PM\_LOW\_LIMIT Low limit | DO | 1E-9 |  |
| PM\_HIGH\_LIMIT High limit | DO | 1000 |  |
| PM\_TIME\_CONST Time constant | DO | 1.0 |  |
| PM\_VARIANCE Variance of measurement noise | DO | 0.1 |  |

The connection to the process component is carried out by an object name (i.e. process component name). The measured pressure attribute is searched automatically. More information about filtering, scaling, electricity supply, simulated value, and faults can be seen from the description of **[MEASUREMENT](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Measurement.html)**.  
**[To contents of this component](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Pressure_measurement.html" \l "Contents)**

**Attributes**

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 2. Attributes, types, default values and descriptions* | | | |
| **ATTRIBUTE** **Property name** | **Type** | **Default value** | **Description** |
| PM\_PROCESS\_COMPONENT | ON | NULL | Name of the process component to which the measurement is connected |
| PM\_OUTPUT\_VALUE Output value | DO | 0.0 | Noncaled output value of the measurement. |
| PM\_SCALED\_OUTPUT\_VALUE Scaled output value | DO | 0.0 | Scaled output value of the module (see low and high limits) |
| PM\_UNIT Unit of output value | CH | UserDefined | Unit of the measurement. If one of the predefined units is used, the scaling of the measurement is fixed (PM\_BIAS and PM\_COEFFICIENT determined automatically). In case of the selection UserDefined, pm\_bias and pm\_coefficient can be freely defined by the user. Predefined units are: MPA = MegaPascal (absolute pressure) KPA = KiloPascal (absolute pressure) KPA\_G = KiloPascal gauge (overpressure) PA = Pascal (absolute pressure) BAR\_G = bar gauge (overpressure) BAR = bar (absolute pressure) MH20\_G = meters water gauge (overpressure) MMH20\_G = millimeters water gauge (overpressure) |
| PM\_BIAS Scale bias | DO | 0.0 | Bias for the measurement. Note! Automatically determined if pm\_unit is one of the predefined units. |
| PM\_COEFFICIENT Scale coefficient | DO | 1.0 | Scaling coefficient for the measurement. Note! Automatically determined if pm\_unit is one of the predefined units. |
| PM\_LOW\_LIMIT Low limit | DO | 0.0 | Lower limit of the measurement range |
| PM\_HIGH\_LIMIT High limit | DO | 100.0 | Upper limit of the measurement range |
| PM\_VALUE State matrix | DO | (2,2) | Matrix indicating inside values of the component: (1,1) & (1,2) = current time step's raw measurement (unlimited) (2,1) & (2,2) = current time step's filtered measurement (unlimited) |
| PM\_TIME\_CONST Time constant | DO | 1.0 | sec. Filtering time constant of the measurement (in seconds) |
| PM\_VARIANCE Variance of measurement noise | DO | 0.0 | Variance of the measurement noise |
| PM\_FAULT\_ON Fault on | LO | F | Logical input by which it is possible to simulate the fault of the measurement |
| PM\_ELECTRIC\_FAULT\_VALUE Value of output at fault | DO | 0.0 | Value of the non-scaled output at electrical (pm\_electric\_supplyt = F) and **other faults (pm\_fault\_on = T)**. |
| PM\_SIM\_MODE\_ON Simulation mode on | LO | F | Logical input, when this input is TRUE, output of the measurement follows the value of the simulation input with a ramp defined with PM\_SIM\_VAL\_RAMP\_TIME |
| PM\_SIMULATION\_VALUE Simulation value | DO | 0.0 | Simulation input of the measurement |
| PM\_ELECTRIC\_SUPPLY Electricity supplied | LO | T | Logical input, indicates if measurement has electricity or not |
| PM\_FAULT\_ON\_S | ON\* | NULL | Signal input of the attribute 'fault\_on' |
| PM\_SIM\_MODE\_ON\_S | ON\* | NULL | Signal input of the attribute 'PM\_SIM\_MODE\_ON' |
| PM\_SIMULATION\_S | ON\* | NULL | Signal input of the attribute 'PM\_SIMULATION\_VALUE' |
| PM\_ELECTRIC\_SUPPLY\_S | ON\* | NULL | Signal input of the attribute 'electric\_supply' |
| PM\_SCALED\_OUT\_SIGN | ON | \* | Name of the scaled output signal of the module |
| PM\_NONSCALED\_OUT\_SIGN | ON | \* | Name of the non scaled output signal of the module |
| PM\_DISTURB\_IND\_SIGN | ON | \* | Name of the alarm signal. Signal is TRUE if electric supply of the module fails, if the fault situation has been selected or if the measured variable is out of defined measurement range |
| PM\_NEW New module | LO | T/F | Logical attribute, should not be modified by the user |
| PM\_EXCEED\_LIMITS Limit exceeding option | IN | 0 | Integer flag to tell whether exceeding low and highlimits is allowed. The scaled output may in cases of allowed exceeding be <0.0 or >1.0! For more information, look table 3. |
| PM\_SIM\_VAL\_RAMP\_TIME Simulation value ramp time | DO | 0.0 | Ramp time (s) for simulation value. When measurement module is changed to simulation mode the output will ramp from the current value to the simulation value in the time defined with this attribute. If the simulation value changes when in simualtion mode the new simulation value is reached again in this time (not faster, not slower). When simulation mode is switched off, the output returns to the process value in one time step. |
| PM\_SEED Seed number | IN | (system time based) | The manually given 1st seed number. Default value is generated based on system time. User can manually change it. Utilised if CURRENT\_SEED = 0. |
| PM\_CURRENT\_SEED Current seed | DO | 0 | Current seed number used to calculate next noise value. If 0 will be generated based on the value given in the SEED attribute. |

|  |  |  |
| --- | --- | --- |
| *Table 3. Limit exceeding option* | | |
| **Value** | **Low limit exceedeng allowed?** | **High limit exceeding allowed?** |
| 0 | no | no |
| 1 | yes | yes |
| 2 | no | yes |
| 3 | yes | no |

[**To contents of this component**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/Pressure_measurement.html#Contents)

**Error messages**

**4133 Check the measurement range of ...:** The upper limit of the measurement is smaller than the lower limit.

**4204 Measurement not properly connected:** A proper connection to measured item is missing. If both connections of the difference measurement are missing, two warnings are given.

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[**Measurement**](http://127.0.0.1:57778/help/topic/fi.vtt.apros.manual/doc-user/html/Combustion/refs/autref/aumea.html)  
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