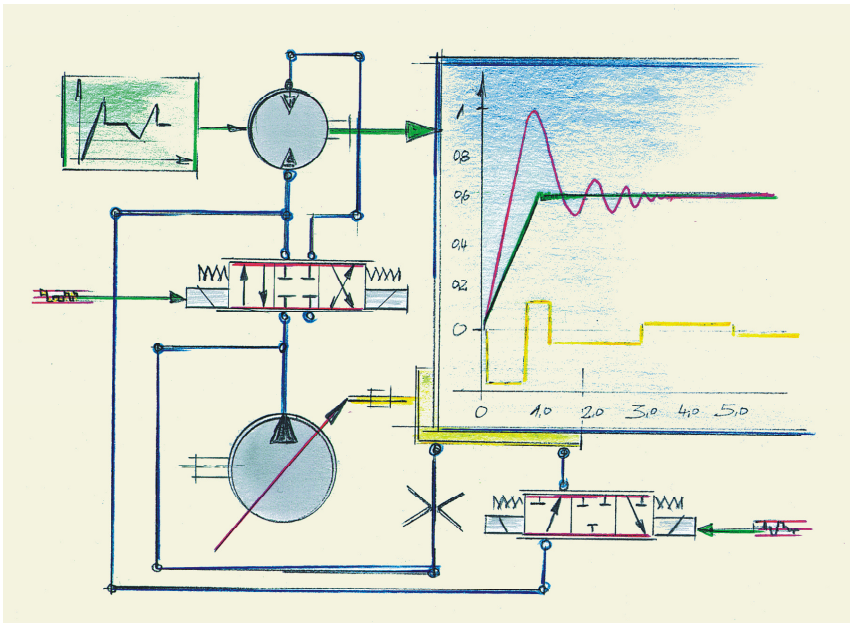
DSHplus

Component Manual

Hydraulics



FLUIDON
Gesellschaft für Fluidtechnik mbH

DSH*plus*

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In the course of further development of the software, parts of this manual can lose their validity.

Introduction

The component manual describes the components of the library. In accordance with the component categories in the library, the manual subdivides itself into several parts:

- Component library Hydraulics
- Component library Pneumatics
- Component library Control,
- Component library Mechanics
- Component library Thermal Hydraulics
- Component library Modules
- Component library Miscellaneous

The HYDRAULICS part contains all hydraulic components of the library. This includes pumps and motors, flow valves, pressure valves, check valves, and directional valves as well as accumulators and pipes.

The PNEUMATICS part of the library includes many components for pneumatic systems. The components range from cylinders and resistors to directional valves and sensors.

In the manual part MECHANICS the mechanical components are described. These are the masses and the spring damper components as well as other mechanical components.

The component library of DSH*plus* includes analog and digital components for control tasks that are explained in the chapter CONTROL.

The THERMAL HYDRAULICS part contains thermal hydraulic components of the library. This includes pumps and motors and directional valves as well as accumulators and pipes.

The component manual should help to select the right component for a model and to parameterize it. Furthermore, there is information about the kind of modeling of the components, e. g. whether they were modeled in accordance with the physical qualities of the real components or whether only their dynamic characteristics were taken.

The MODULES contains the components for the DSH*plus*-STC and for the sub model prepare. The part MISCELLANEOUS contains other components to which the nodes in particular belong.

All components are described according to the same scheme. The following page shows an example component with which the scheme is explained.

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ComponentName

Symbol of the component

Symbol

Sketch

Drawing of the component

Connectors and Variables

Name	Type	Unit	Description
Hydraulic connector	Hydr	Unit	*short description*
Hydraulic volume less connector	Hvol	Unit	*short description*
Thermal hydraulic connector	THydr	Unit	*short description*
Pneumatic connector	Pneu	Unit	*short description*
Signal input	In		*short description*
Signal output	Out		*short description*
Mechanical connector	Mech		*short description*
Internal variable	V		*short description*

Parameters

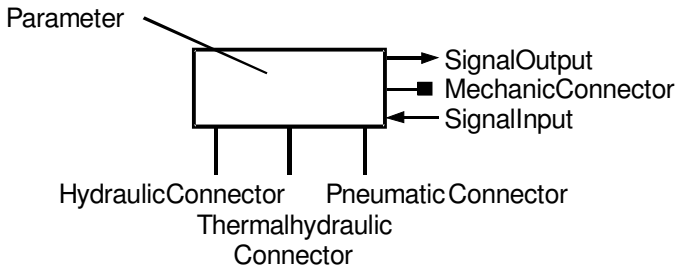
Name	Value	Unit	Description
Parameter name	*Value*	*Unit*	*short description*

Notes

Remarks about function and application

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Comments to the example component:

	The component symbol is the symbol with which a component appears in the library and in the model.
	The component with its parameters and its connectors is represented in the component drawing according to the following figure:  The arrows at the component specify whether the connector is an input, an output or a mechanical connection. The direction of state variables is defined by a coordinate system.
	In the table **Connectors and Variables,** all connectors and variables of a component are listed.
	The connectors and variables of a component can be subdivided into different types. They are characterized in the column **Type** in accordance with: Hydr: hydraulic connector Pneu: pneumatic connector Thydr: thermal hydraulic connector In: input of a signal Out: output of a signal Mech: mechanical connector V: internal variable (state variable)
	Units (column **Unit**) were assigned to the variables. In so far as the customer does not change the Units, the graphic or numeric edition of the variables occurs with these Units. The units for the values of the other connectors are listed only for better understanding.
	In the parameter list, all **parameters** are listed with its **Values** and **Units** with which a component is described.
	The **Notes** give further remarks to the function and the application of the component.
	The following spelling is used: COMPONENTNAME *Parameters*, *Connectors* and *Variables*

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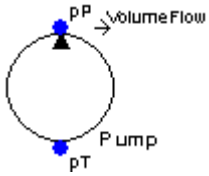
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Hydraulics

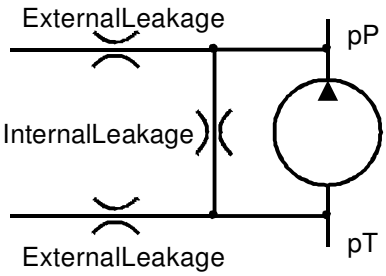
Pumps

Pump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	working pressure
pT	Hydr	bar	reservoir pressure
VolumeFlow	Out	l/min	delivery

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow at no leakage
InternalLeakage	0.01	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts

Notes

The component part PUMP constitutes a model of a flow source in which the delivery is calculated from the given nominal flow and the leakage. The leakage is dependent on the adjacent pressure difference *pP - pT*.

The *VolumeFlow* refers to the connection *pP*.

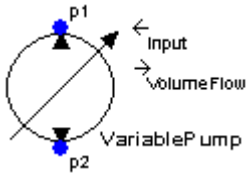
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The component part PUMP does not provide a model of the physical design of a pump but only copies its characteristic features. Thus, physical parameters (e.g. inertia moment or hydraulic-mechanical efficiency) are not parameterized.

A model of an invariable flow source is also available as a component part in which the dependency of flow and adjacent pressure difference is described via a characteristic field (PUMPCHARACTERISTICS).

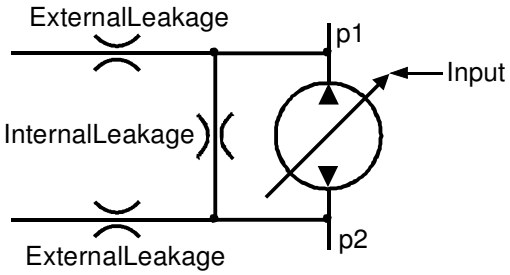
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VariablePump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hyd	bar	pressure 1
p2	Hyd	bar	pressure 2
VolumeFlow	Out	l/min	Delivery
Input	In	-	signal for the control of the pump displacement

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow at no leakage and at maximum displacement
InternalLeakage	0.01	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
InputMax	1	-	standardization parameter for the input signal
InputMin	-1	-	standardization parameter for the input signal
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts

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Notes

The component part VARIABLEPUMP constitutes a model of a variable flow source, The delivery is calculated from the parameters *VolumeFlow,* the input signal and the leakage. The leakage is dependent on the adjacent pressure difference *pP - pT*.

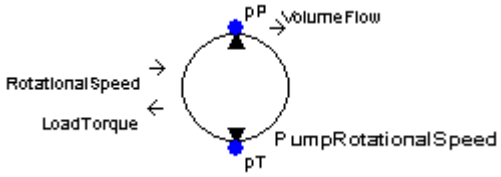
Depending on the direction of the rotation, both *p1* and *p2* can designate the high pressure side of the pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *p1*.

The component part VARIABLEPUMP is no model of the physical design of a pump but only copies its characteristic features. Therefore, physical characteristics (e.g. inertia moment or hydraulic-mechanical efficiency) are not parameterized.

A model of a variable flow source is also available as a component part in which the dependency on the *VolumeFlow*, input signal, and adjacent pressure difference can be described via a look-up-table (VARIABLEPUMPCHARACTERISTICS).

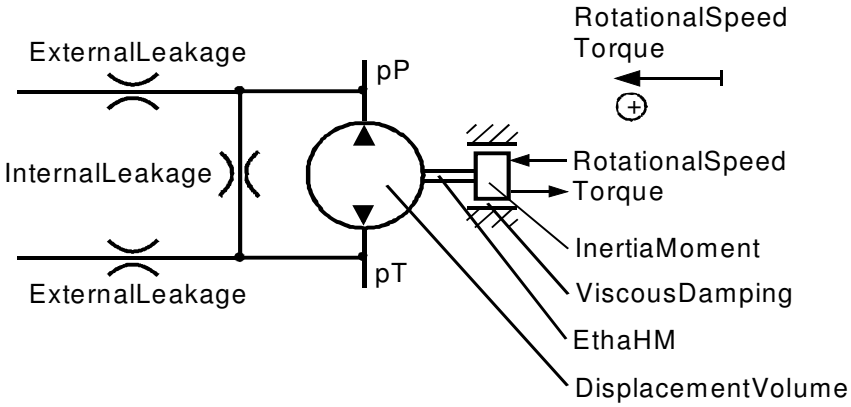
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PumpRotationalSpeed



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
PP	Hydr	bar	working pressure
PT	Hydr	bar	reservoir pressure
RotationalSpeed	In	1/min	input of rotational speed
VolumeFlow	Out	l/min	delivery
LoadTorque	Out	Nm	required torque of the drive at given rotational speed

Parameters

Name	Value	Unit	Description
DisplacementVolume	32	cm³	delivery at a rotation of the pump without leakage
ViscousDamping	1	Nms	speed-dependent damping
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts
InternalLeakage	0.01	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
EthaHM	1	-	hydro-mechanical efficiency

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Name	Value	Unit	Description
InertiaMoment	0.05	kgm²	inertia moment of the rotating parts of the pump
DifferentiationTime	1	ms	help parameter for calculation of the momentum
PrefixMomentum	-1	-	prefix of output

Notes

The component part PUMPROTATIONALSPEED constitutes a model of a displacement pump in which the *RotationalSpeed* is predefined and the required *Torque* of the drive is calculated. Inertia and friction momentum are considered.

The torque is differentiated from the spin equation. This demands the parameter D*ifferentiationTime*.

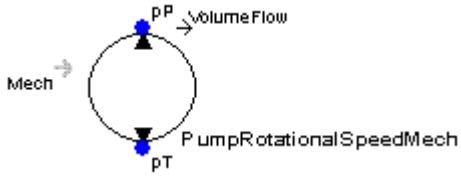
By means of the parameter *PrefixMomentum* the prefix of the *Torque* can be adjusted according to the requirements for the connection to further component parts.

Depending on the direction of the rotation, both *pP* and *pT* can designate the high pressure side of the pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

A model of a pump with variable angular velocity is also available as a component part in which the connections for the *AngularVelocity* and the *Torque* are united in one mechanical connection (PUMPROTATIONALSPEEDMECH).

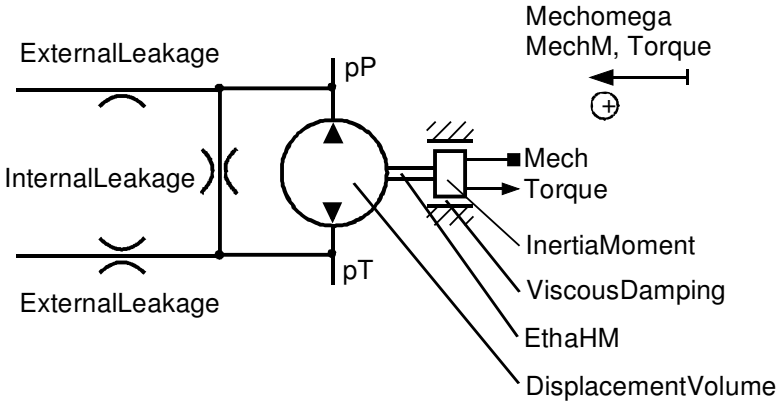
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PumpRotationalSpeedMech



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	working pressure
pT	Hydr	bar	reservoir pressure
Mech	Mech	-	mechanical connection
Mechomega	In	deg/s	angular velocity
MechM	Out	Nm	required torque
VolumeFlow	Out	l/min	delivery

Parameters

Name	Value	Unit	Description
DisplacementVolume	32	cm³	displacement volume at a rotation without leakage
InertiaMoment	0.05	kgm²	Inertia moment of working parts of the pump
ViscousDamping	1	Nms	speed-dependent damping
InternalLeakage	0.01	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts

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EthaHM	1	-	hydro-mechanical efficiency
DifferentiationTime	1	ms	help parameter for calculation of the momentum
PrefixMomentum	-1	-	prefix for the output of the momentum

Notes

The component part PUMPROTATIONALSPEEDMECH constitutes a model of a displacement pump in which the *RotationalSpeed* is predefined and the required *Torque* of the drive is calculated. Inertia and friction momentum are considered. The connections for the angular velocity (*Mechomega*) and the output torque (*MechM*) are united in the mechanical connection *Mech.*

The *Torque* is differentiated from the spin equation. This demands the parameter *DifferentiationTime*.

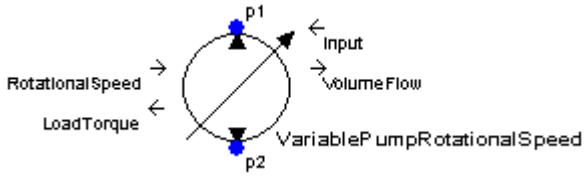
By means of the parameter *PrefixMomentum* the prefix of the *Torque* can be adjusted according to the requirements for the connection to further component parts.

Depending on the direction of the rotation, both *pP* and *pT* can designate the high pressure side of the pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

A model of a pump with variable angular velocity is also available as a component part in which the connections for the *AngularVelocity* and the *Torque* can be connected separately (PUMPROTATIONALSPEED).

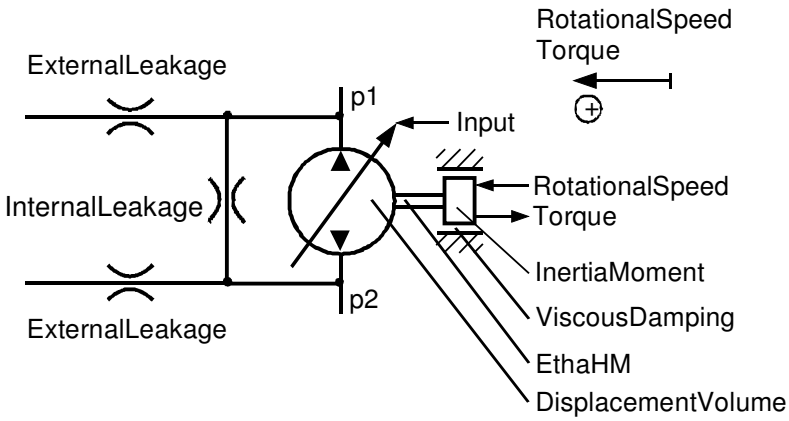
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VariablePumpRotationalSpeed



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
RotationalSpeed	In	1/min	input of rotational speed
Input	In	-	signal for the control of the pump displacement
LoadTorque	Out	Nm	required torque of the drive at predefined rotational speed
VolumeFlow	V	-	auxiliary variable

Parameters

Name	Value	Unit	Description
DisplacementVolume	32	cm³	displacement volume at a rotation of the pump without leakage
InertiaMoment	0.05	kgm²	inertia moment of working parts of the pump
ViscousDamping	1	Nms	speed-dependent damping
InternalLeakage	0.01	l/min/bar	internal leakage

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Name	Value	Unit	Description
ExternalLeakage	0	l/min/bar	theoretical pump delivery
EthaHM	1	-	hydro-mechanical
DifferentiationTime	1	ms	auxiliary variable
PrefixMomentum	-1	-	prefix of output
InputMin	-1	-	standardization parameter for the input signal
InputMax	1	-	standardization parameter for the input signal
CavitationPressure	-0.5	Bar	Pressure limit at which cavitation starts

Notes

The component part VARIABLEPUMPROTATIONALSPEED constitutes a model of a displacement pump in which the *RotationalSpeed* is predefined and the required *Torque* of the drive is calculated. Inertia and friction momentum are considered.

The *Torque* is differentiated from the spin equation. This demands the parameter *DifferentiationTime*.

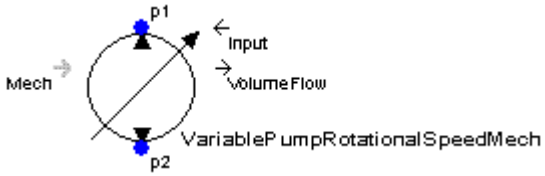
By means of the parameter *PrefixMomentum* the prefix of the momentum can be adjusted according to the requirements for the connection to further component parts.

Depending on the direction of the rotation, both *p1* and *p2* can designate the high pressure side of then pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *p1*.

A model of a displacement pump with variable angular velocity is also available as a component part in which the connections for the *AngularVelocity* and the *Torque* are united in one mechanical connection (VARIABLEPUMPROTATIONALSPEEDMECH).

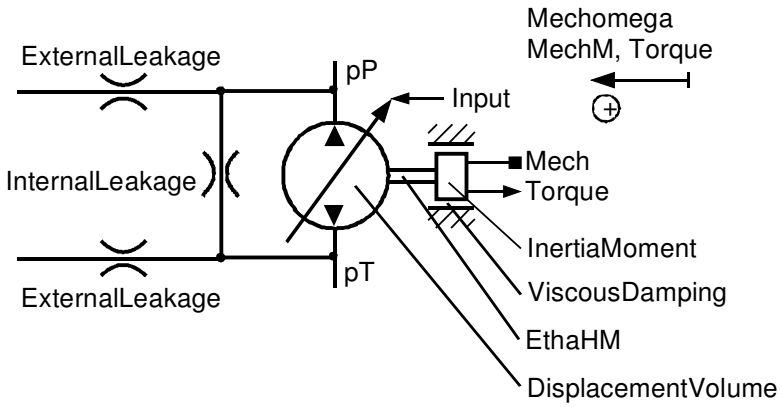
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VariablePumpRotationalSpeedMech



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	working pressure
p2	Hydr	bar	reservoir pressure
Input	In	-	signal for the control of the pump displacement
Mech	Mech	-	mechanical connection
Mechomega	In	deg/s	angular velocity
MechM	Out	Nm	required torque
VolumeFlow	Out	l/min	delivery

Parameters

Name	Value	Unit	Description
DisplacementVolume	32	cm³	displacement volume at a rotation of the pump without leakage
InertiaMoment	0.05	kgm²	inertia moment of working parts of the pump
ViscousDamping	1	Nms	speed-dependent damping
InternalLeakage	0.01	l/min/bar	internal leakage

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Name	Value	Unit	Description
ExternalLeakage	0	l/min/bar	theoretical pump delivery
EthaHM	1	-	hydro-mechanical efficiency
DifferentiationTime	1	ms	help parameter for calculation of the momentum
InputMin	-1	-	standardization parameter for the input signal
InputMax	1	-	standardization parameter for the input signal
CavitationPressure	-0.5	Bar	Pressure limit at which cavitation starts
PrefixMomentum	-1	-	prefix of output

Notes

The component part VARIABLEPUMPROTATIONALSPEEDMECH constitutes a model of a displacement pump in which the *RotationalSpeed* is predefined and the required *Torque* of the drive is calculated. Inertia and friction momentum are considered. The connections for the angular velocity (*Mechomega*) and the output torque (*MechM*) are united in the mechanical connection *Mech*.

The *Torque* is differentiated from the spin equation. This demands the parameter *DifferentiationTime*.

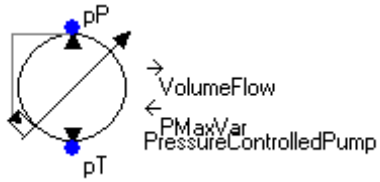
By means of the parameter *PrefixMomentum* the prefix of the *Torque* can be adjusted according to the requirements for the connection to further component parts.

Depending on the direction of the rotation, both *pP* and *pT* can designate the high pressure side of the pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

A model of a pump with variable angular velocity is also available as a component part in which the connections for the *AngularVelocity* and the *Torque* can be connected separately (PUMPROTATIONALSPEED).

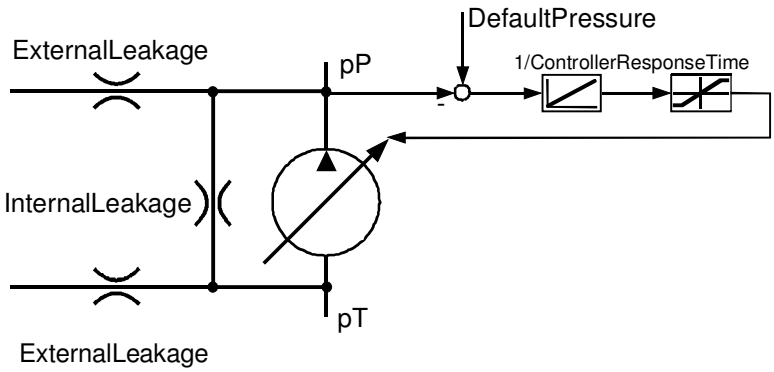
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PressureControlledPump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	working pressure
pT	Hydr	bar	reservoir pressure
VolumeFlow	Out	l/min	delivery
PMaxVar	In	kW	external maximum pump power default

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	delivery at total displacement of the pump without leakage
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
ControllerResponseTime	100	ms	time constant for the control system
DefaultPressure	100	bar	default pressure of the pump
Adjustmentmin	0	%	Minimum pump adjustment
Adjustmentmax	100	%	Maximum pump adjustment

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Name	Value	Unit	Description
CavitationPressure	-0.5	Bar	Pressure limit at which cavitation starts
PMax	100	kW	Maximum power

Notes

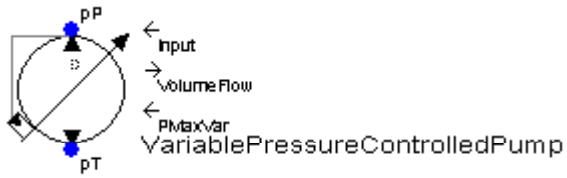
The component part PRESSURECONTROLLEDPUMP constitutes a model that represents a pressure controlled pump according to its control parameters. The pressure control comes up to a PT_1-controler with a time constant *ControllerResponseTime*. During the simulation the nominal pressure of the pump stays constant.

(Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

A model of a pressure controlled pump is also available as a component part in which the nominal pressure is variable during the simulation (VARIABLEPRESSURECONTROLLEDPUMP).

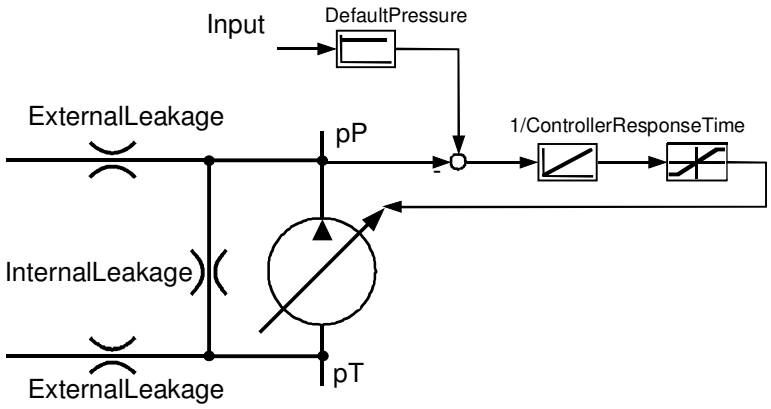
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VariablePressureControlledPump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
PP	Hydr	bar	working pressure
PT	Hydr	bar	reservoir pressure
Input	In	-	input signal to adjust the nominal pressure
VolumeFlow	Out	l/min	delivery
PMaxVar	In	kW	external maximum pump power default

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	delivery at total displacement of the pump without leakage
DefaultPressure	100	bar	default pressure of the pump
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	theoretical pump delivery
ControllerResponseTime	100	ms	time constant for the control system

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Name	Value	Unit	Description
InputMin	0	-	standardization parameter for the input signal
InputMax	1	-	standardization parameter for the input signal
Adjustmentmin	0	%	
Adjustmentmax	0	%	
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts
Pmax	100	kW	Maximum power

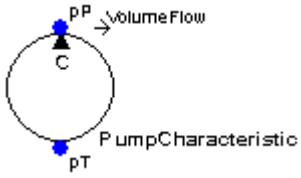
Notes

The component part VARIABLEPRESSURECONTROLLEDPUMP constitutes a model that represents a pressure controlled pump according to its control parameters. The pressure control comes up to a PT_1-controler with a time constant *ControllerResponseTime*. During the simulation the nominal pressure of the pump stays constant.

(Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

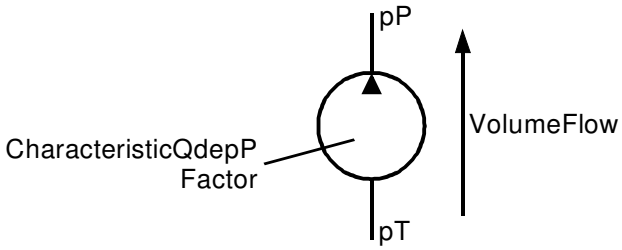
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PumpCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	working pressure
pT	Hydr	bar	reservoir pressure
VolumeFlow	Out	l/min	delivery

Parameters

Name	Value	Unit	Description
CharacteristicQdepP	-	-	look-up-table, which describes the flow in dependence on the pressure difference
Factor	1	-	factor to squeeze or stretch the look-up-table

Notes

The component part PUMPCHARACTERISTICS constitutes a model that represents a flow source which describes the flow in dependence on the applied pressure differenc *pP - pT* via a look-up-table.

$$VolumeFlow = Factor \cdot f_{CharacteristicQdepP}(pP - pT)$$

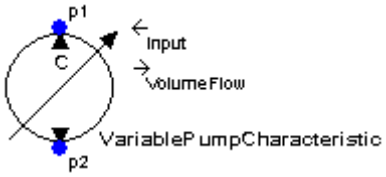
(Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *pP*.

The look-up-table can be compressed and/or stretched via the parameter Factor. In case the pressure difference is more than- or falls below the range of the look-up-table, it is calculated with the respective boundary value the look-up-table.

A model of an unchangeable pump is also available as a component, with that the flow is computed from a defaulted *VolumeFlow* and the leakage. (*Pump*).

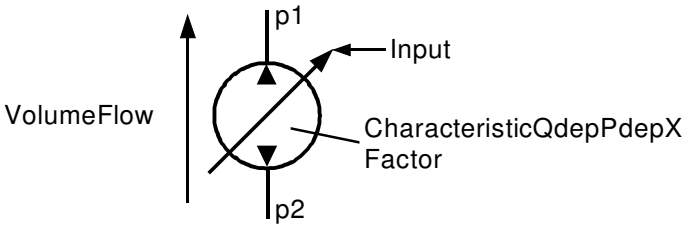
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VariablePumpCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Input	In	-	signal to control the pump displacement
VolumeFlow	Out	l/min	delivery

Parameters

Name	Value	Unit	Description
CharacteristicQdepPdepX	-	-	look-up-table, which describes the flow in dependence on the pressure difference
Factor	1	-	factor to squeeze or stretch the look-up-table

Notes

The component part PUMPCHARACTERISTICS constitutes a model that represents a flow source which describes the flow in dependence on the applied pressure differenc *pP - pT* and an input signal (*Input*) via the two dimensional look-up-table CHARACTERISTICQDEPPDEPX.

$$VolumeFlow = Factor \cdot f_{\text{CHARACTERISTICQDEPPDEPX}}(p1 - p2, Input)$$

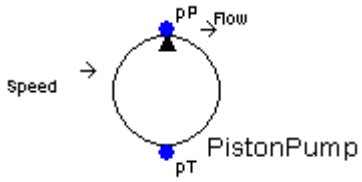
The pressure difference *p1 - p2* is defined as *Input 1* and *Input* as *Input 2* of the look-up-table.

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Depending on the direction of the rotation, both *p1* and *p2* can designate the high pressure side of the pump. (Irrespective of the delivery direction) The *VolumeFlow* on principle refers to the connection *p1*.

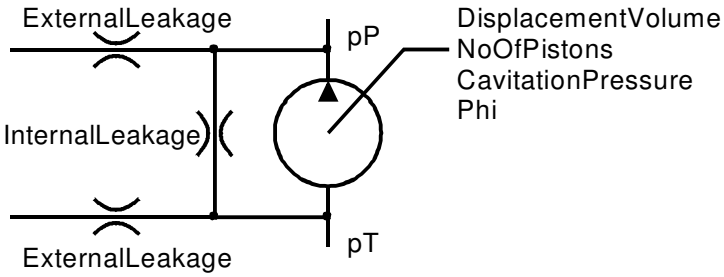
The look-up-table can be compressed and/or stretched via the parameter Factor. In case the pressure difference is more than- or falls below the range of the look-up-table, it is calculated with the respective boundary value the look-up-table.

PistonPump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	working pressure
pT	Hydr	bar	reservoir pressure
Flow	Out	l/min	delivery
Speed	Out	1/min	specified speed

Parameters

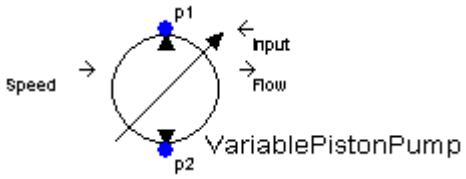
Name	Value	Unit	Description
DisplacementVolume	10	cm³	Displacement volume
NoOfPistons	1	1	Number of pistons
InternalLeakage	0.001	l/min/bar	Internel leakage of the pump
ExternalLeakage	0	l/min/bar	Extenal leakage of the pump
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts
Phi	0	deg	Angle of the pistons

Notes

The component PISTONPUMP constitutes a model that represents a flow source which describes the flow in dependence on the applied pressure differenc *pP - pT* and an input Speed.

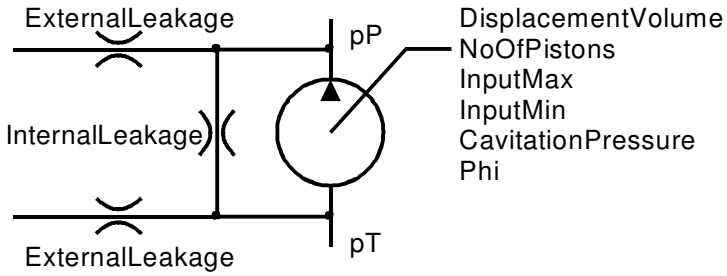
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VariablePistonPump



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Input	In	-	signal to control the pump displacement
Flow	Out	l/min	delivery
Speed	Out	1/min	Specified speed

Parameters

Name	Value	Unit	Description
DisplacementVolume	10	cm³	Displacement volume
NoOfPistons	1	1	Number of pistons
InputMax	1	1	Standard maximum value of the Input signal
InputMin	-1	1	Standard minimum value of the Input signal
InternalLeakage	0.001	l/min/bar	Internal leakage in the pump
ExternalLeakage	0	l/min/bar	External leakage in the pump
CavitationPressure	-0.5	bar	Pressure limit at which cavitation starts
Phi	0	deg	Angle of the pistons

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Notes

The component VARIABLEPISTONPUMP is a model of an variable pump with different volume flow pulsation, which depends on the number of pistons, revolution and the input signal.

For the Volumeflow:

Input = 0 -> Volumeflow = 0

Input = 1 -> Volumeflow = Qmax

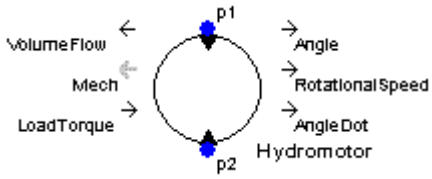
Input = 0 < n < 1 -> Volumeflow = 0 < Q < Qmax

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Motors

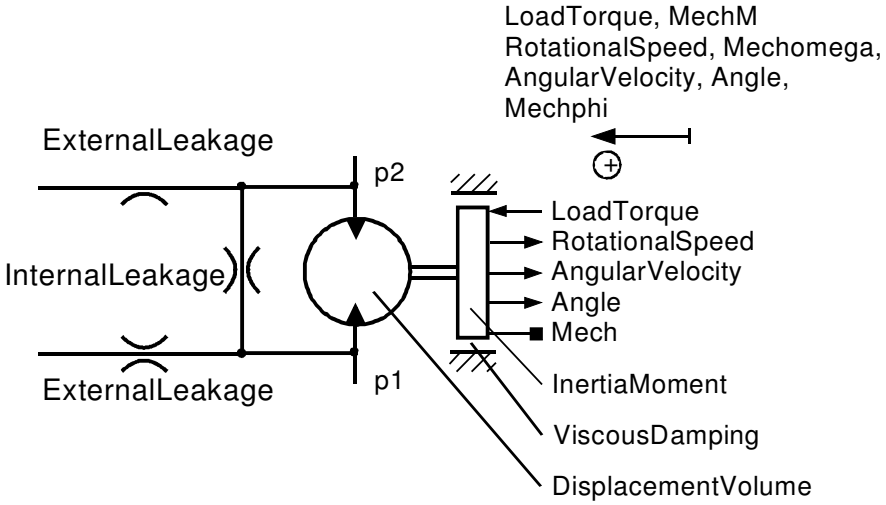
Rotational Motors

HydroMotor



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Mech	Mech	-	mechanical connector
MechM	In	Nm	torque at the motor
Mechphi	Out	deg	angle
Mechomega	Out	deg/s	angular velocity
LoadTorque	In	Nm	torque at the motor
RotationalSpeed	Out	1/min	rotational speed of the motor
Angle	Out	deg	Angle of the motor
VolumeFlow	Out	l/min	flow at connector p1
AngleDot	Out	rad/s	Angular velocity of the motor

Parameters

Name	Value	Unit	Description
DisplacementVolume	50	cm³	displacement volume of the motor
InertiaMoment	1	kgm²	inertia momentum of working parts of the motor
ViscousDamping	1	Nms	velocity depending damping
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	external leakage

Notes

The component HYDROMOTOR is the model of a hydraulic constant motor.

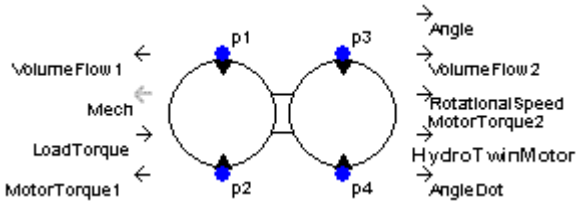
Depending on the sense of rotation, both *p1* and *p2* can designate the high pressure side of the motor. If *p1 > p2* a positive sense of rotation results. If *LoadTorque > 0* a positive acceleration results.

Volumeflow refers (independent of the sense of rotation) fundamentally to the connector *p1*.

At the mechanical connector *Mech* of the HYDROMOTOR the angle of the motor (*Mechphi*), the rotational speed (*Mechomega*) and the load torque (*MechM*) are summarized.

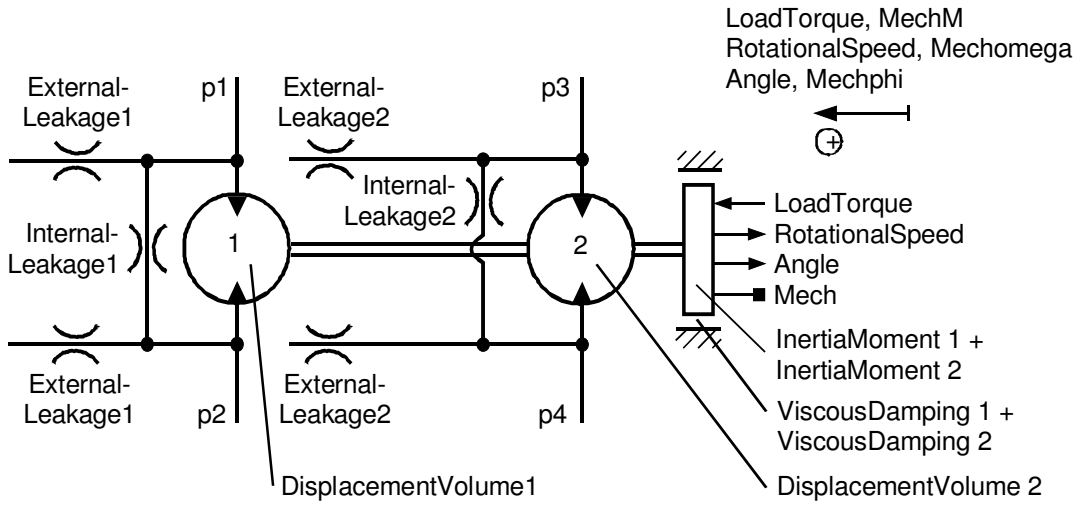
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HydroTwinMotor



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
p3	Hydr	bar	pressure 3
p4	Hydr	bar	pressure 4
Mech	Mech	-	mechanical connector
MechM	In	Nm	torque at the motor
Mechphi	Out	deg	angle
Mechomega	Out	deg/s	angular velocity
LoadTorque	In	Nm	torque at the motor
RotationalSpeed	Out	1/min	rotational speed of the motor
Angle	Out	deg	angle of the motors
Volumenflow1	Out	l/min	flow at connector p1
Volumenflow2	Out	l/min	flow at connector p3
AngleDot	Out	rad/s	Angular velocity of the motor

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Name	Type	Unit	Description
MotorTorque1	Out	Nm	torque of the motor 1
MotorTorque2	Out	Nm	torque of the motor 2

Parameters

Name	Value	Unit	Description
DisplacementVolume1	50	cm³	displacement volume of the motor (motor 1)
DisplacementVolume2	50	cm³	displacement volume of the motor (motor 2)
InertiaMoment1	1	kgm²	inertia momentum of working parts of the motor 1
InertiaMoment2	1	kgm²	inertia momentum of working parts of the motor 2
ViscousDumping1	1	Nms	velocity depending damping (motor 1)
ViscousDumping2	1	Nms	velocity depending damping (motor 2)
InternalLeakage1	0.001	l/min/bar	internal leakage (motor 1)
InternalLeakage2	0.001	l/min/bar	internal leakage (motor 2)
ExternalLeakage1	0	l/min/bar	external leakage (motor 1)
ExternalLeakage2	0	l/min/bar	external leakage (motor 2)

Notes

The component HydroTwinMotor is the model of two hydraulic constant motors that are assembled on one shaft. In addition, a hydraulic transformer can be realized with the component.

Depending on the sense of rotation, both *p1 and p3* and *p2 and p4* can designate the high pressure side of the motor. If *p1 > p2* or *p3 > p4* a positive sense of rotation results. If *LoadTorque > 0* a positive acceleration results.

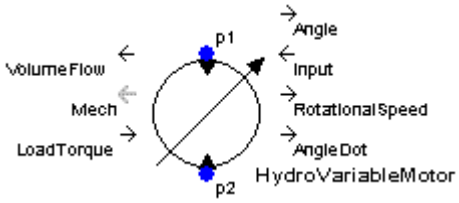
Volumeflow1 refers (independent of the sense of rotation) fundamentally to the connector *p1*, the *Volumeflow2* on *p3*.

At the connectors *MotorTorque1* and *MotorTorque2*, the torque transferred effectively by the motors can be obtained.

At the mechanical connector *Mech* of the HydroTwinMotor the angle of the motor (*Mechphi*), the rotational speed (*Mechomega*) and the load torque (*MechM*) are summarized.

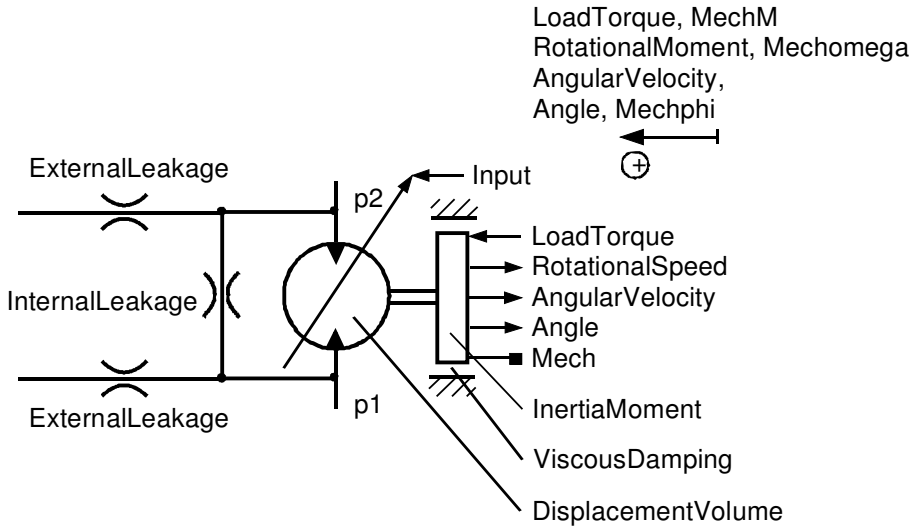
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HydroVariableMotor



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Mech	Mech	-	mechanical connector
MechM	In	Nm	torque at the motor
Mechphi	Out	deg	angle
Mechomega	Out	deg/s	angular velocity
LoadTorque	In	Nm	torque at the motor
Input	In	-	input signal for the displacement of the motor
RotationalSpeed	Out	1/min	rotational speed of the motor
VolumeFlow	Out	l/min	flow at connector p1
Angle	Out	deg	angle of the motors
AngleDot	Out	Rad/S	Angular velocity of the motor

Parameters

Name	Value	Unit	Description
DisplacementVolume	50	cm³	displacement volume of the motor
InertiaMoment	1	kgm²	inertia momentum of working parts of the motor
ViscousDamping	1	Nms	velocity depending damping
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	external leakage
InputMin	-1	-	standardization parameter for the input signal
InputMax	1	-	standardization parameter for the input signal

Notes

The component HYDROVARIABLEMOTOR is the model of a hydraulic motor with a variable displacement.

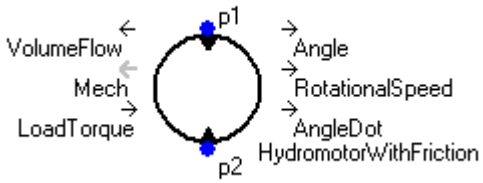
Depending on the sense of rotation, both *p1* and *p2* can designate the high pressure side of the motor. If *p1 > p2* a positive sense of rotation results. If *LoadTorque > 0* a positive acceleration results.

Volumeflow refers (independent of the sense of rotation) fundamentally to the connector *p1*.

At the mechanical connector *Mech* of the HYDROMOTOR the angle of the motor (*Mechphi*), the rotational speed (*Mechomega*) and the load torque (*MechM*) are summarized.

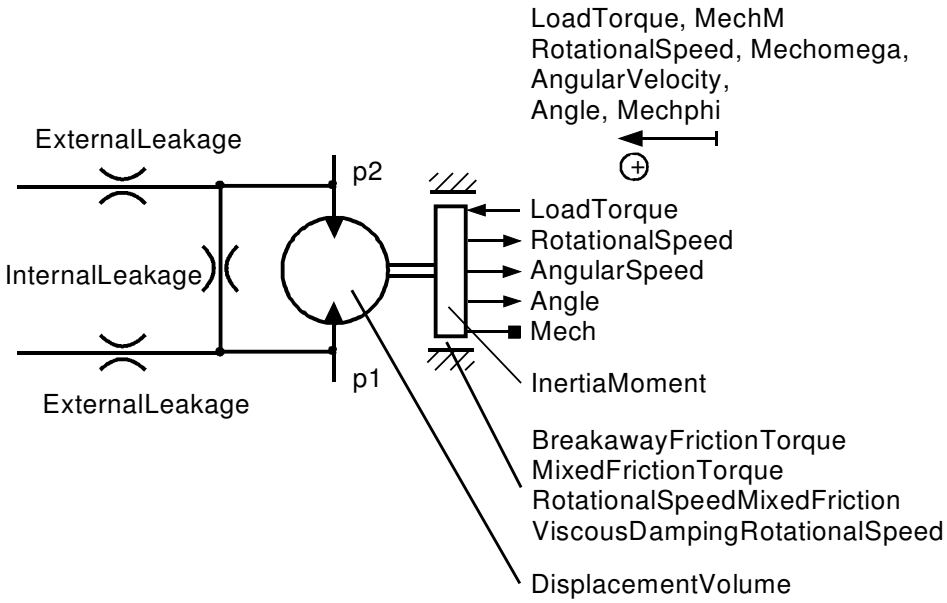
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HydroMotorWithFriction



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	Bar	pressure 1
p2	Hydr	bar	pressure 2
Mech	Mech	-	mechanical connector
MechM	In	Nm	torque at the motor
Mechphi	Out	deg	angle
Mechomega	Out	deg/s	angular velocity
LoadTorque	In	Nm	torque at the motor
RotationalSpeed	Out	1/min	rotational speed of the motor
Angle	Out	deg	Angle of the motor
AngularVelocity	Out	deg/min	angular velocity of the motor
VolumeFlow	Out	l/min	flow at connector p1

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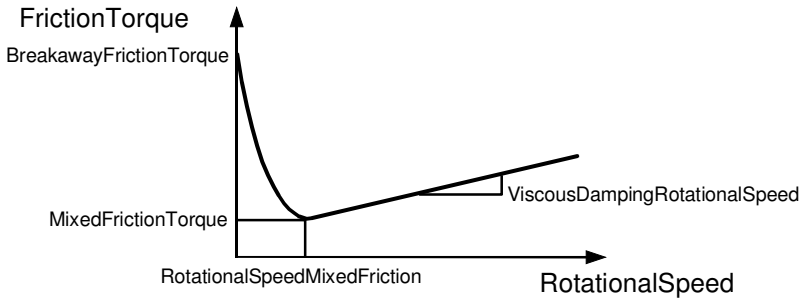
Parameters

Name	Value	Unit	Description
DisplacementVolume	50	cm³	displacement volume of the motor
BreakawayFrictionTorque	10	Nm	characteristic for Stribeck curve
MixedFrictionTorque	1	Nm	characteristic for Stribeck curve
RotSpeedMixedFriction	1	1/min	characteristic for Stribeck curve
ViscousDampingRotSpeed	1	Nms	characteristic for Stribeck curve
Inertia	0.05	kgm²	inertia momentum of working parts of the motor
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage	0	l/min/bar	external leakage

Notes

The component HydroMotorWithFriction is the model of a hydraulic constant motor. Within this model the velocity depending friction is modeled, too.

The friction is modeled in accordance to the Stribeck curve. The parameters *BreakawayFrictionTorque*, *MixedFrictionTorque*, *RotationalSpeedMixedFriction* and *ViscousDampingRotationalSpeed* represents the characteristic values shown in the figure. The friction is independent on the pressure.



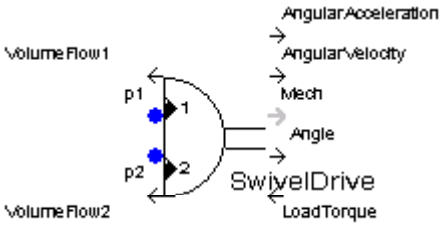
Depending on the sense of rotation, both *p1* and *p2* can designate the high pressure side of the motor. If *p1 > p2* a positive sense of rotation results. If *LoadTorque > 0* a positive acceleration results.

Volumeflow refers (independent of the sense of rotation) fundamentally to the connector *p1*.

At the mechanical connector *Mech* of the HydroMotorWithFriction the angle of the motor (*Mechphi*), the rotational speed (*Mechomega*) and the load torque (*MechM*) are summarized.

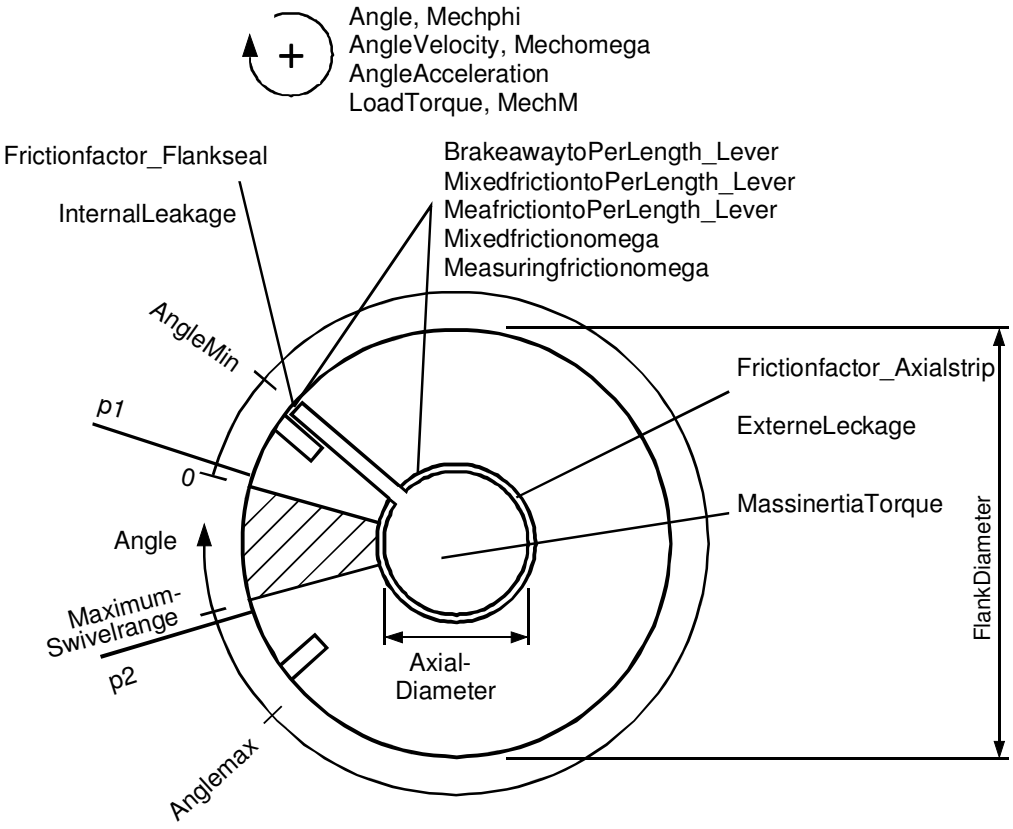
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SwivelDrive



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	Bar	pressure 1
p2	Hydr	bar	pressure 2
Mech	Mech	-	mechanical connector
MechM	In	Nm	torque at the motor
Mechphi	Out	deg	angle
Mechomega	Out	deg/s	angular velocity
VolumeFlow1	Out	l/min	flow at connector p1

Name	Type	Unit	Description
VolumefFlow2	Out	l/min	flow at connector p2
AngularAcceleration	Out	deg/min²	angular acceleration of the motor
AngularVelocity	Out	deg/min	angular velocity of the motor
Angle	Out	deg	Angular displacement of the motor
LoadTorque	In	Nm	torque at the motor

Parameters

Name	Value	Unit	Description
AxialDiameter	24	mm	Diameter of the swivel axis
FlankDiameter	50	mm	Diameter of the pump
FlankLength	20	mm	Length of the Vane
MaximumSwivelrange	180	deg	Swivel range of the Pump
AngleMin	0	deg	Minimum angle
AngleMax	180	deg	Maximum Angle
MassinertiaTorque	1.0E-4	Kgm²	Mass Inertia torque of the Pump
BrakeawaytoPer-Length_Lever	0	Nm/mm²	Characteristic value of Stribeck curve
MixedfrictiontoPer-Length_Lever	0	Nm/mm²	Characteristic value of Stribeck curve
MeafrictiontoPer-Length_Lever	0	Nm/mm²	Characteristic value of Stribeck curve
Mixedfrictionomega	0.0001	deg/s	Characteristic value of Stribeck curve
Measuringfrictionomega	0.0002	deg/s	Characteristic value of Stribeck curve
Frictionfactor_Flankseal	0.5	1/bar	Pressure dependent friction factor of the Flankseal
AvailableAxialsealing	0		
Frictionfactor_Axialstrip	0.5	1/bar	Pressure dependent friction factor of the axial strip
ExternalLeakage1	0	l/min/bar	External pressure dependent Leakage
ExternalLeakage2	0	l/min/bar	External pressure dependent Leakage
InternalLeakage	0	l/min/bar	Internal pressure dependent Leakage

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Notes

The component SWIVELDRIVE is a modell of an Hydraulic swivel motor in which the frictional torque of the vane anf Axial Seal has been calculated using the stribeck friction curve.

The component has been constructed based on the Swivel drive where by the characteristic values have been parameterized.

The parameter maximum swivelling range specifies the greatest possible angle of rotation of the vane drive. Over Anglemin and Anglemax notices can be stopped in this range, whereby angle min and angle max must be positive. Angle min is > 0 and angle max < maximum swivelling range remains to dead volumes in the chambers, if the wing drives into one of the notices.

In the Stribeck curves, over which the friction moments of the wing and Axial seals to be determined are calculated over the length of the seals and on the associated lever arms by the application of Angularvelocity. The seal between Vane and housing, which seals, and separates the two chambers of the vane drive at the axle, and the sealing which seals between axle and housings, which avoid a fluid leakage from the engine,should be taken care of. If the parameter Available Axial sealing is set to zero, the friction moment of the axial sealings is neglected.

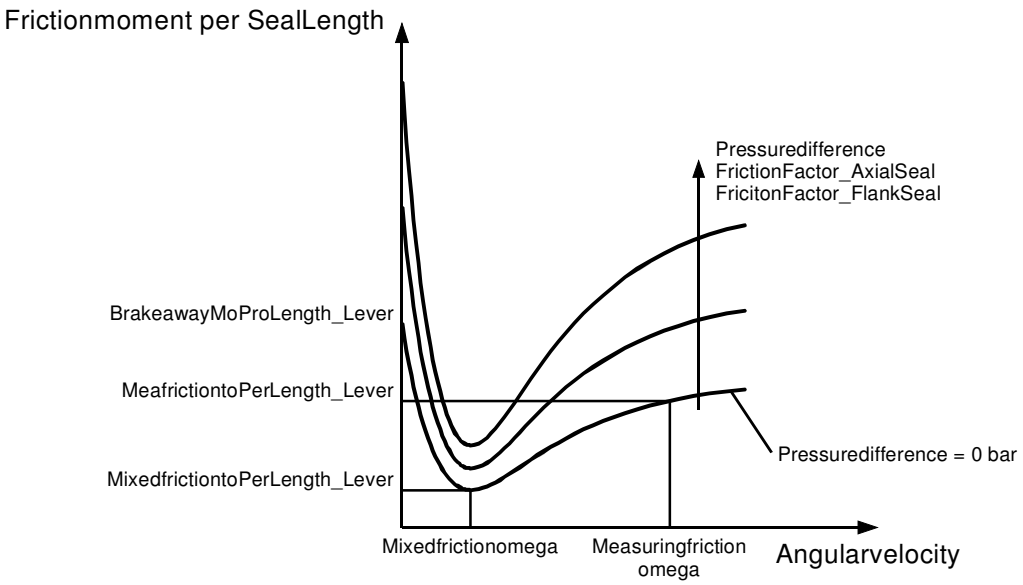
The Stribeck curves are produced for mixing friction omega and measuring friction omega for a difference of pressure by 0 bar from the characteristic values

The pressure dependence of the friction moments is calculated over the parameter factors (FricitonFactor_FlankSeal and/or FrictionFactor_AxialSeal):

FrictionmomentPressuredifference $\neq 0$ =

= FrictionmomentPressuredifference = 0 (1 + |Pressuredifference| · Factor)

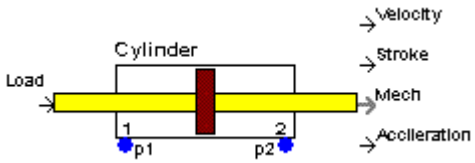
In the following picture the Stribeck curve is represented:



In the mechanical connection *Mech* of the component, the angle, the angular velocity, and the Load torque has been represnted.

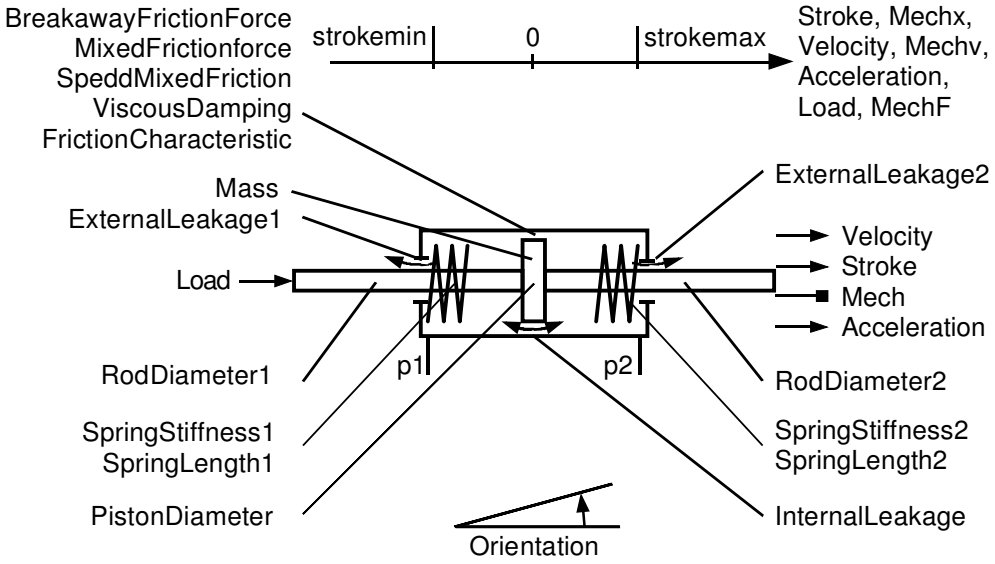
Linear Motors

Cylinder



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Load	In	N	force at the piston
Mech	Mech	-	mechanical connection
MechF	In	N	force at the piston
Mechx	Out	mm	stroke of the piston
Mechv	Out	m/s	velocity of the piston
MechPipe	Mech	-	mechanical connection
MechF	Out	N	inner force at the cylinder-pipe
Mechx	In	Mm	Stroke of the cylinder pipe
Mechv	In	m/s	Velocity of the cylinder pipe
Acceleration	Out	m/s^2	acceleration of the piston

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Name	Type	Unit	Description
Velocity	V	m/s	velocity of the piston
Stroke	Out	mm	stroke of the piston

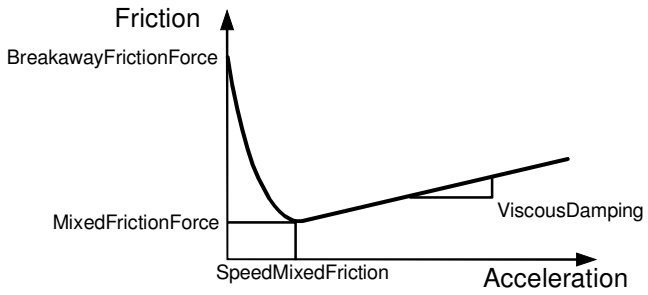
Parameters

Name	Value	Unit	Description
PistonDiameter	100	mm	diameter of the piston
RodDiameter1	50	mm	diameter of rod 1
RodDiameter2	0	mm	diameter of rod 2
Mass	10	kg	mass of pistons and piston rods
Orientation	0	deg	angle between the movement plane and the horizontal plane
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage1	0	l/min/bar	theoretical piston delivery at piston rod 1
ExternalLeakage2	0	l/min/bar	theoretical piston delivery at piston rod 2
BreakawayFrictionForce	100	N	characteristic for Stribeck curve
MixedFrictionForce	10	N	characteristic for Stribeck curve
SpeedMixedFriction	0.1	m/s	characteristic for Stribeck curve
ViscousDamping	10	Ns/m	characteristic for Stribeck curve
FrictionCharacteristic	-	-	one dimensional look-up table for the velocity dependant friction description
strokemax	100	mm	maximum stroke of the piston in positive direction
strokemin	-100	mm	maximum stroke of the piston in negative direction
SpringStiffness1	0	N/mm	stiffness of spring 1
SpringLength1	0	mm	active length of spring 1
SpringStiffness2	0	N/mm	stiffness of spring 2
SpringLength2	0	mm	active length of spring 2
FluidMassConsideration	0	-	consideration of fluid mass in the dynamic system calculation (1=on ; 0=off)

Notes

The component CYLINDER is the model of a synchronizing or differential cylinder which has two hydraulic ports. If a differential cylinder is required, one rod diameter (*RodDiameter1* or *RodDiameter2*) must only be parameterized with zero. In this case, the external leakage (*ExternalLeakage1* or *ExternalLeakage2*) is automatically set to zero for this cylinder side. The symbol for the cylinder can be a synchronizing or a differential cylinder.

The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping* represents the characteristic values shown in the figure. The friction is not influenced by the inclination of the movement plane and it is independent on the pressure.



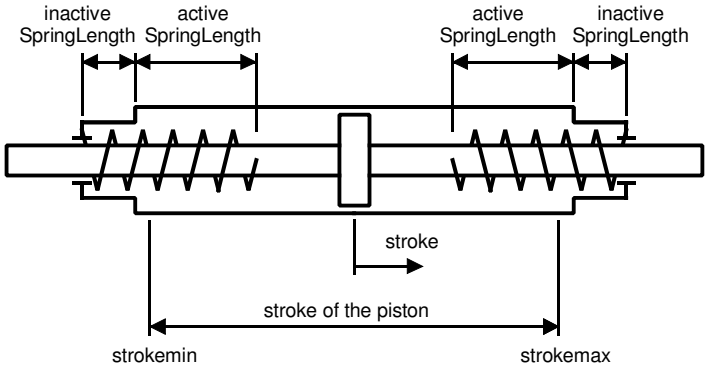
The friction force is also definable with a look-up table $F_{Friction}(v)$. The friction is also definable with a look-up table ($F_{friction}(v)$. If a table is selected it will be used, if not, the normal parameters for the friction description are used. The look-up table is defined in one quarter only for positive velocity include 0. The component calculates with the absolute value.

The mechanical connector *Mech* transmits the variables *MechF* as well as stroke *Mechx* and velocity *Mechv* summarized.

Accompiend by the mechanical connector *MechPipe* the cylinder is supported against the environment. Because of the massless cylinderpipe in the modell , an external mass has to be connected. This external mass again has to be supported with a spring surrendered against the environment.

With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

The parameter *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a cylinder in which the inactive lengths of the springs are also drawn in:

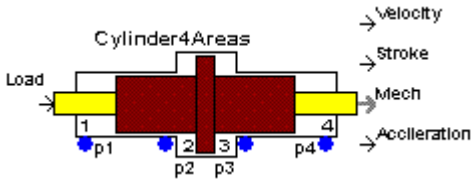


The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the piston (*strokemax* - *strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

With the help of the parameter *FluidMassConsideration* the influence of the fluid mass on the system behaviour could be taken into consideration. The weight force as well as the mass inertia of the relevant part of fluid, depending on cylinder orientation and piston position, are intergrated into the system calculation.

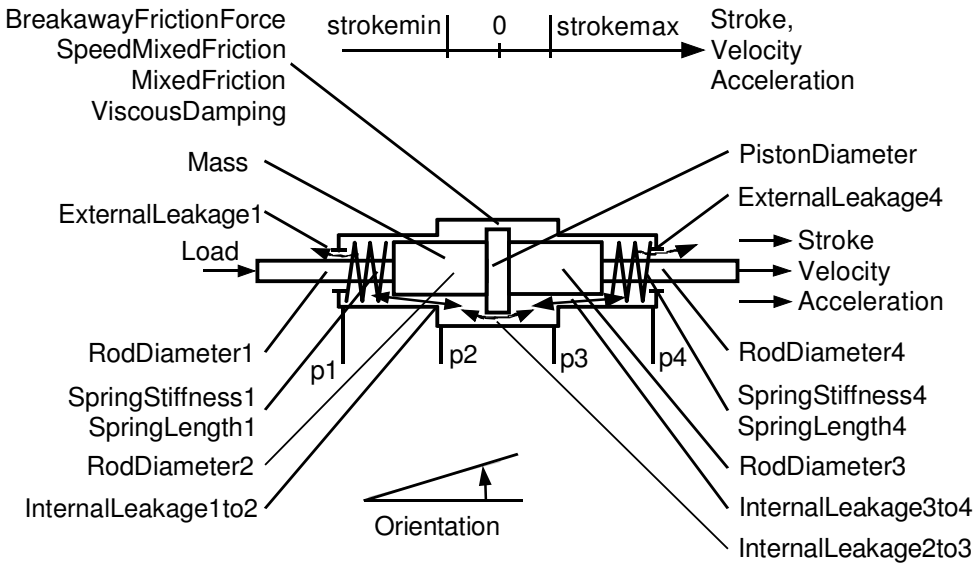
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Cylinder4Areas



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
p3	Hydr	bar	pressure 3
p4	Hydr	bar	pressure 4
Mech	Mech	-	mechanical connection
MechF	In	N	force at the piston
Mechx	Out	Mm	stroke of the piston
Mechv	Out	m/s	velocity of the piston
Load	In	N	force at the piston
Acceleration	Out	m/s^2	acceleration of the piston
Velocity	Out	m/s	velocity of the piston
Stroke	Out	mm	stroke of the piston

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Parameters

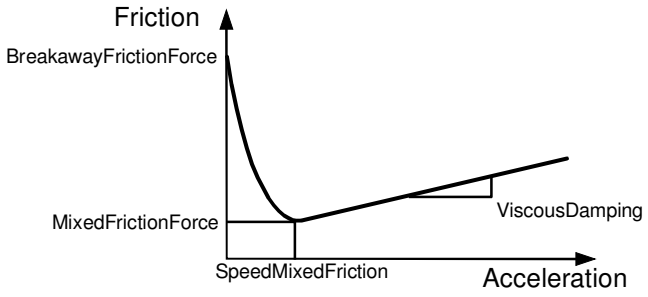
Name	Value	Unit	Description
PistonDiameter	100	mm	diameter of the piston
RodDiameter1	50	mm	diameter of rod 1
RodDiameter2	70	mm	diameter of rod 2
RodDiameter3	70	mm	diameter of rod 3
RodDiameter4	50	mm	diameter of rod 4
strokemax	100	mm	maximum stroke of the piston in positive direction
strokemin	-100	mm	maximum stroke of the piston in negative direction
Mass	10	kg	mass of pistons and piston rods
Orientation	0	deg	angle between the movement plane and the horizontal plane
BreakawayFrictionForce	100	N	characteristic for Stribeck curve
MixedFrictionForce	10	N	characteristic for Stribeck curve
SpeedMixedFriction	0.1	m/s	characteristic for Stribeck curve
ViscousDamping	10	Ns/m	characteristic for Stribeck curve
ExternalLeakage1	0	l/min/bar	external leakage at rod 1
ExternalLeakage4	0	l/min/bar	external leakage at rod 1
InternalLeakage1to2	0.001	l/min/bar	internal leakage between chamber 1 and chamber 2
InternalLeakage2to3	0.001	l/min/bar	internal leakage between chamber 2 and chamber 3
InternalLeakage3to4	0.001	l/min/bar	internal leakage between chamber 3 and chamber 4
SpringLength1	0	mm	active length of spring 1
SpringStiffness1	0	N/mm	stiffness of spring 1
SpringLength4	0	mm	active length of spring 4
SpringStiffness4	0	N/mm	stiffness of spring 4

Notes

The component CYLINDER4AREAS is the model of a synchronizing or differential cylinder which has four hydraulic ports.

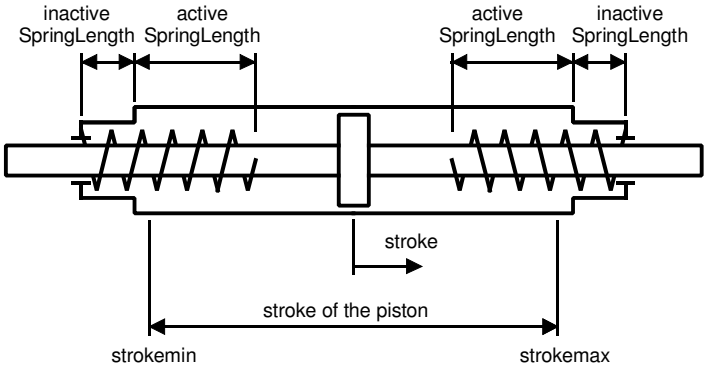
The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping* represents the characteristic values shown in the figure. The friction is not influenced by the inclination of the movement plane and it is independent on the pressure.

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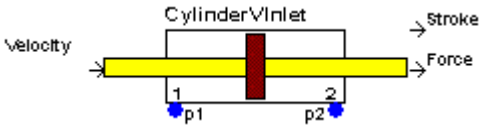
With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

The parameter *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a cylinder in which the inactive lengths of the springs are also drawn in:



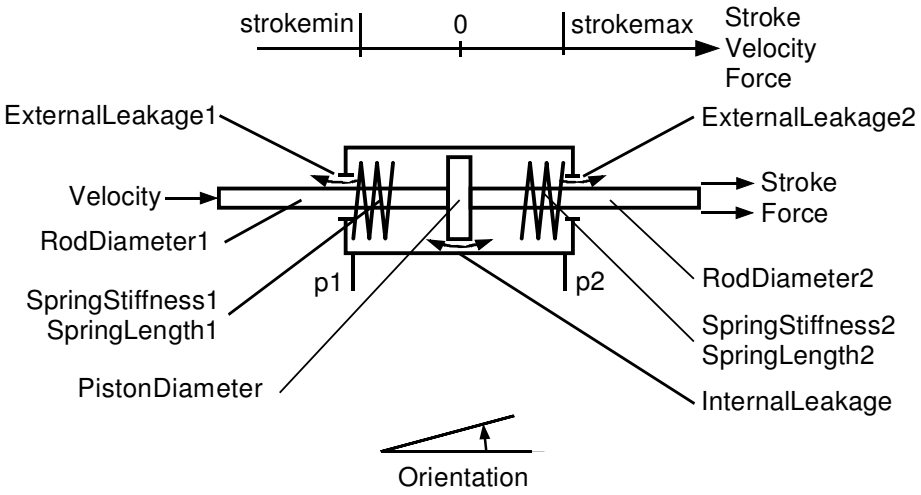
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the piston (*strokemax* - *strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

CylinderVInlet



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Velocity	In	m/s	velocity of the piston
Stroke	Out	mm	stroke of the piston
Force	Out	N	Force that the cylinder generates

Parameters

Name	Value	Unit	Description
PistonDiameter	100	mm	diameter of the piston
RodDiameter1	50	mm	diameter of rod 1
RodDiameter2	0	mm	diameter of rod 2
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage1	0	l/min/bar	external leakage at rod 1
ExternalLeakage2	0	l/min/bar	external leakage at rod 2

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Name	Value	Unit	Description
strokemax	100	mm	maximum stroke of the piston in positive direction
strokemin	-100	mm	maximum stroke of the piston in negative direction
SpringStiffness1	0	N/mm	stiffness of spring 1
SpringLength1	0	mm	active length of spring 1
SpringStiffness2	0	N/mm	stiffness of spring 2
SpringLength2	0	mm	active length of spring 2

Notes

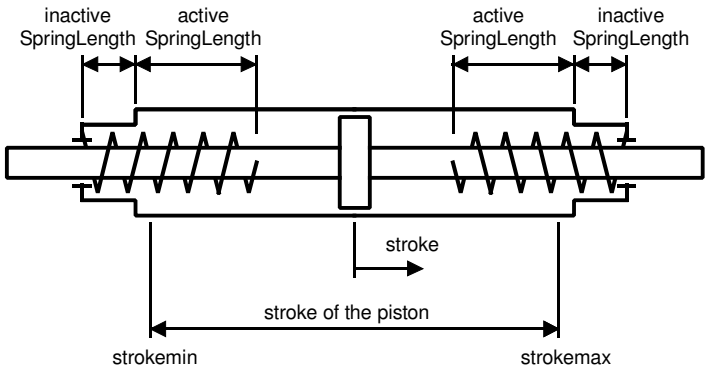
The component CYLINDERVINLET is the model of a synchronizing or differential cylinder which has two hydraulic ports. The velocity of the piston is an input value, the force, that the cylinder generates, is an output value.

If a differential cylinder is required, one rod diameter (*RodDiameter1* or *RodDiameter2*) must only be parameterized with zero. In this case, the external leakage (*ExternalLeakage1* or *ExternalLeakage2*) is automatically set to zero for this cylinder side. The symbol for the cylinder can be a synchronizing or a differential cylinder.

The friction force has to be modeled in the connected system (internal or external).

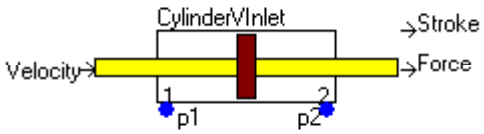
With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

The parameter *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a cylinder in which the inactive lengths of the springs are also drawn in:



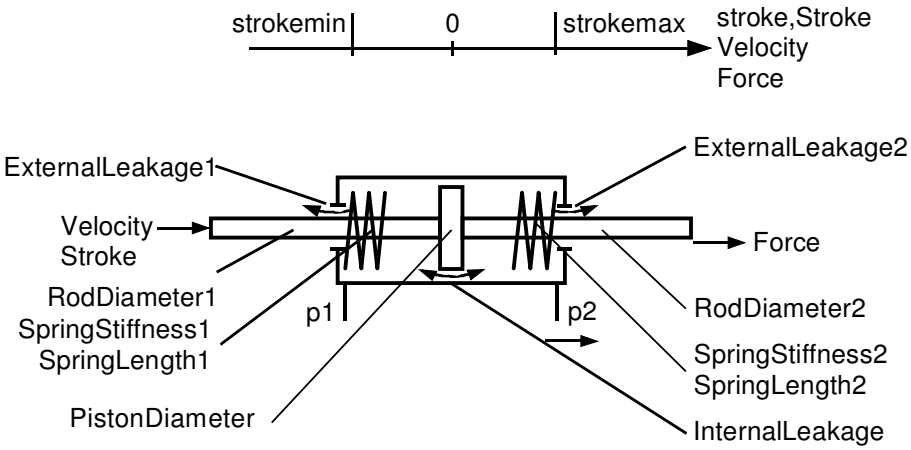
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the piston (*strokemax* - *strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

CylinderXVInlet



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	Pressure 1
p2	Hydr	bar	Pressure 2
Velocity	In	m/s	velocity of the piston
Stroke	In	mm	stroke of the piston
Force	Out	N	Force that the cylinder generates

Parameters

Name	Value	Unit	Description
PistonDiameter	100	mm	diameter of the piston
RodDiameter1	0	mm	diameter of rod 1
RodDiameter2	50	mm	diameter of rod 2
InternalLeakage	100	N	internal leakage

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Name	Value	Unit	Description
ExternalLeakage1	0.001	l/min/bar	external leakage at rod 1
ExternalLeakage2	0	l/min/bar	external leakage at rod 2
strokemax	100	mm	maximum stroke of the piston in positive direction
strokemin	-100	mm	maximum stroke of the piston in negative direction
SpringStiffness1	0	N/mm	stiffness of spring 1
SpringLength1	0	mm	active length of spring 1
SpringStiffness2	0	N/mm	stiffness of spring 2
SpringLength2	0	mm	active length of spring 2

Notes

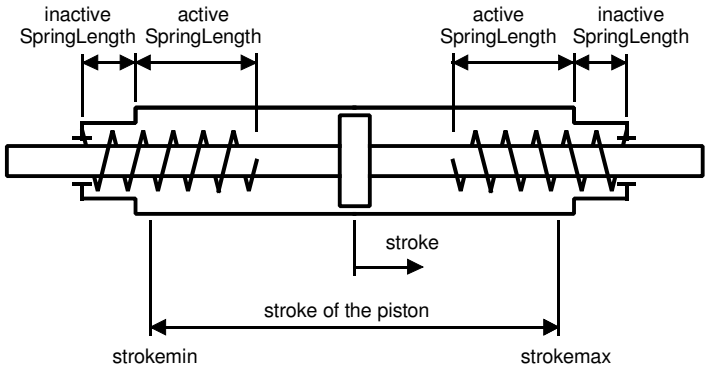
The component CYLINDERXVINLET is the model of a synchronizing or differential cylinder which has two hydraulic ports. The velocity and the stroke of the piston are an input value, the force, that the cylinder generates, is an output value.

If a differential cylinder is required, one rod diameter (*RodDiameter1* or *RodDiameter2*) must only be parameterized with zero. In this case, the external leakage (*ExternalLeakage1* or *ExternalLeakage2*) is automatically set to zero for this cylinder side. The symbol for the cylinder can be a synchronizing or a differential cylinder.

The friction force has to be modeled in the connected system (internal or external).

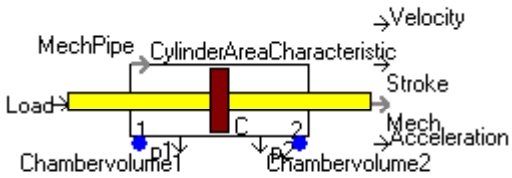
With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

The parameter *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a cylinder in which the inactive lengths of the springs are also drawn in:



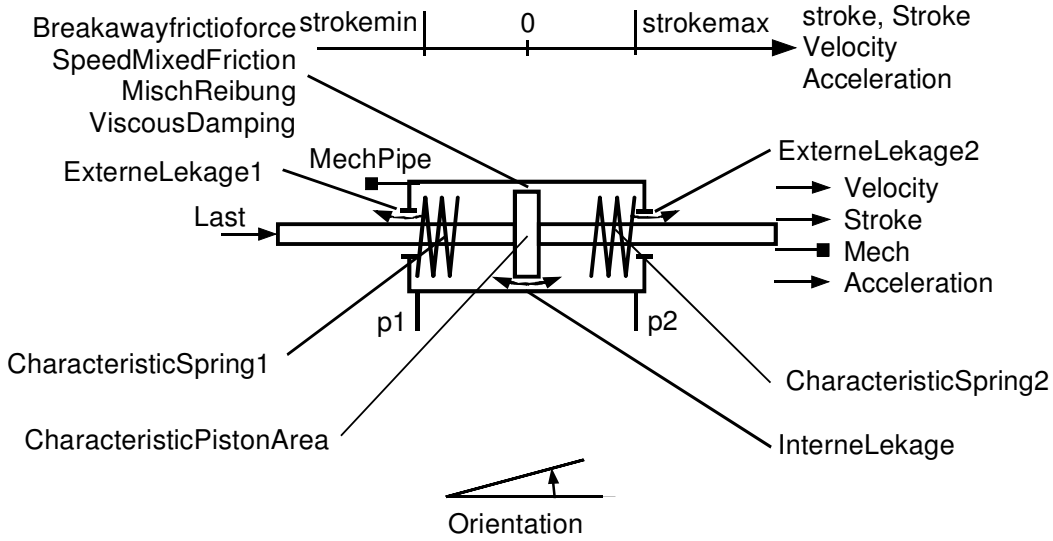
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the piston (*strokemax* - *strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

CylinderAreaCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	Pressure 1
p2	Hydr	bar	Pressure 2
Load	In	N	force at the piston
Mech	Mech	-	mechanical connection
MechF	In	N	force at the piston
Mechx	Out	mm	stroke of the piston
Mechv	Out	m/s	velocity of the piston

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Name	Type	Unit	Description
MechPipe	Mech	-	mechanical connection
MechF	Out	N	inner force at the cylinder-pipe
Mechx	In	mm	Stroke of the cylinderpipe
Mechv	In	m/s	Velocity of the cylinderpipe
Acceleration	Out	m/s^2	Acceleration of the piston
velocity	V	m/s	velocity of the piston
stroke	V	mm	stroke of the piston
Stroke	Out	mm	stroke of the piston
Chambervolume1	Out	-	Actual volume of cylinderroom1
Chambervolume2	Out	-	Actual volume of cylinderroom2

Parameters

Name	Value	Unit	Description
VolumeResolution	1	Mm	diameter of the piston
strokemax	100	Mm	maximum stroke of the piston in positive direction
strokemin	-100	mm	maximum stroke of the piston in negative direction
Mass	10	kg	mass of pistons and piston rods
Orientation	0	deg	angle between the movement plane and the horizontal plane
InternalLeakage	0.001	l/min/bar	internal leakage
ExternalLeakage1	0	l/min/bar	theoretical piston delivery at piston rod 1
ExternalLeakage2	0	l/min/bar	theoretical piston delivery at piston rod 2
BreakawayFrictionForce	100	N	characteristic for Stribeck curve
SpeedMixedFriction	0.1	m/s	characteristic for Stribeck curve
MixedFrictionForce	10	N	characteristic for Stribeck curve
ViscousDamping	10	Ns/m	characteristic for Stribeck curve
CharacteristicPistonArea	-1.		characteristic of the stroke dependent piston area
CharacteristicSpring1			stroke dependent spring force in room 1
CharacteristicSpring2	-1.		stroke dependent spring force in room 2

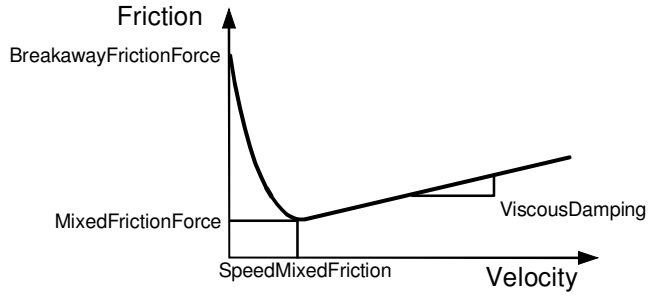
Notes

The component CYLINDERAREACHARACTERISTIC is the model of a synchronizing cylinder which has two hydraulic ports. The variable piston area realizes arbitrary cylinder geometries, like f.e. gum/resin coatings/coverings/films.

The area of the piston is defined in dependence to stroke through the characteristic *CharacteristicPistonArea* and the characteristic has to be between the value strokemin and strokemax.

To increase the calculation velocity the stroke dependent volume of both cylinder rooms is calculated by simulation and selected/chosen at the running time. The parameter *VolumeResolution* defines with which stroke dependent resolution the volume values are calculated.

The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping* represents the characteristic values shown in the figure. The friction is not influenced by the inclination of the movement plane and it is independent on the pressure.



With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

Springs are possibly deserted to each cylinder room in kind of a stroke dependent spring force characteristic(parameters *CharacteristicSpring* 1 and *CharacteristicSpring* 2). So even non linear spring force progressions like f.e. gum/resin coatings/coverings/films can be mapped comfortable/easy.

In the mechanical connector *Mech* of the component the stroke of the cylinders (*Mechx*), the velocity (*Mechv*) and the load (*MechF*) are sumarized.

Accompiend by the mechanical connector *MechPipe* the cylinder is supported against the environment. Because of the massless cylinderpipe in the modell , an external mass has to be connected. This external mass again has to be supported with a spring surrendered against the environment.

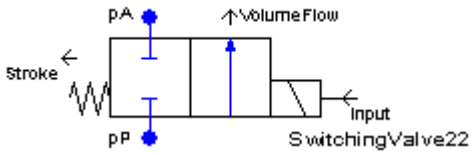
If the cylinder is in an inclinate position the *Orientation* serves to consider the massforce.

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Directional Valves

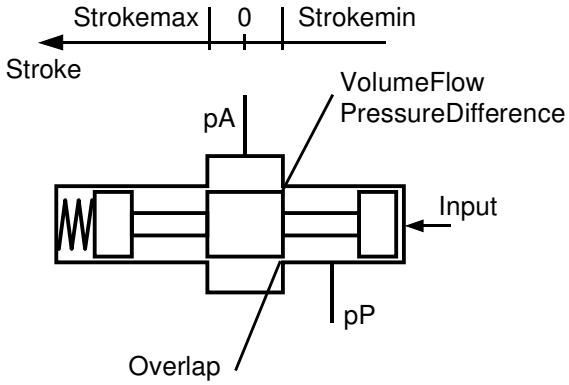
2-x Valves

SwitchingValve22



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for opening motion

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Name	Value	Unit	Description
SwitchingTimeClose	3	ms	time for closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve
Overlap	0	%	relative overlap of the metering edge

Notes

The component SWITCHINGVALVE22 is a model of a 2-way switching valve at which the flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

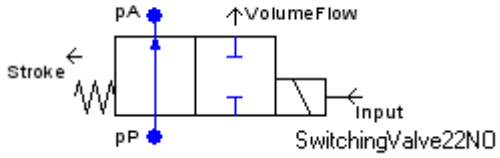
For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*.

The component SWITCHINGVALVE22 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way switching valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SWITCHING-VALVE22CHARACTERISTICS).

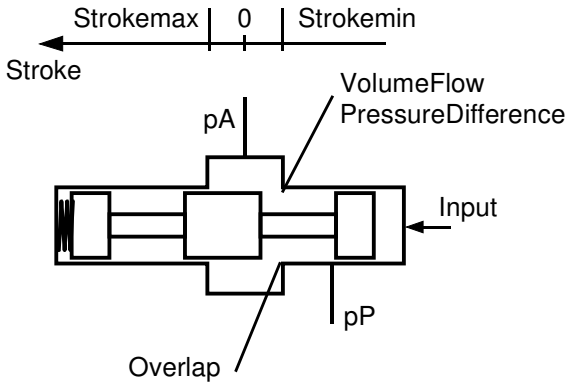
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SwitchingValve22NO



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for opening motion
SwitchingTimeClose	3	ms	time for closing motion

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Name	Value	Unit	Description
SwitchingThreshold	0	-	Value of the input signal to open the valve
Overlap	0	%	relative overlap of the metering edge

Notes

The component SWITCHINGVALVE22NO is a model of a 2-way switching valve at which the flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*. The valve is normally open.

The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

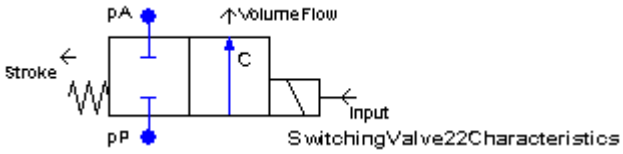
For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*.

The component SWITCHINGVALVE22NO does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way switching valve is also available as a component, at which the valve is normally closed (SWITCHINGVALVE22) and at which the flow characteristic is parameterized with a look-up table (SWITCHINGVALVE22CHARACTERISTICS).

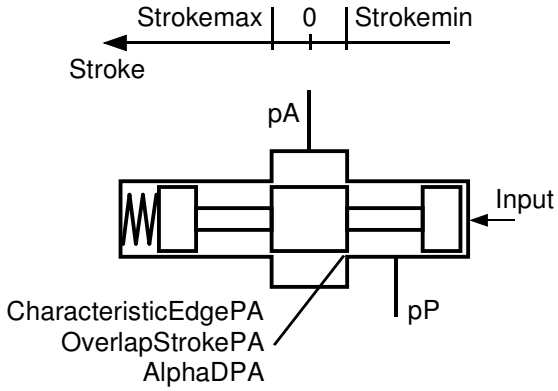
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SwitchingValve22Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for opening motion
SwitchingTimeClose	3	ms	time for closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve

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Name	Value	Unit	Description
OverlapStrokePA	0	mm	complete overlap for the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
TDifference	0	K	Difference between local and system temperature

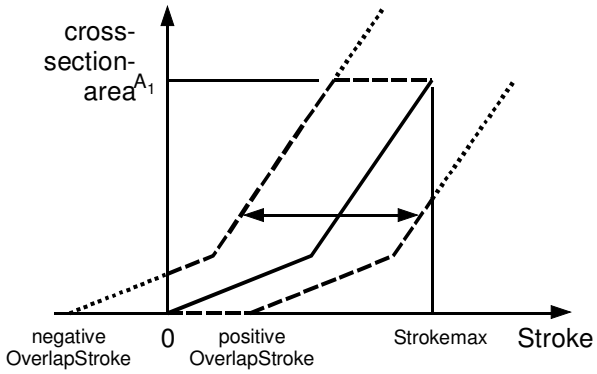
Notes

The component SWITCHINGVALVE22CHARACTERISTICS is a model of a 2-way switching valve. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

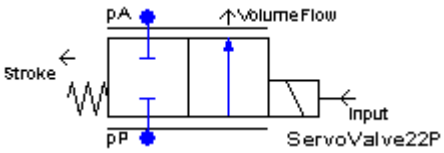
For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*.

The component SWITCHINGVALVE22CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way switching valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SWITCHINGVALVE22).

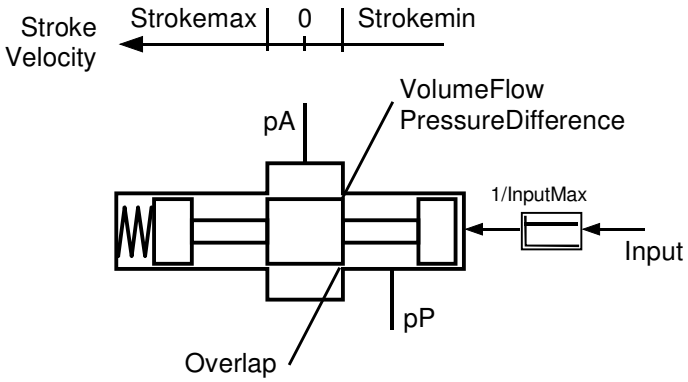
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ServoValve22P



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edge

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Notes

The component SERVOVALVE22P is a model of a 2-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The following rule is effective:

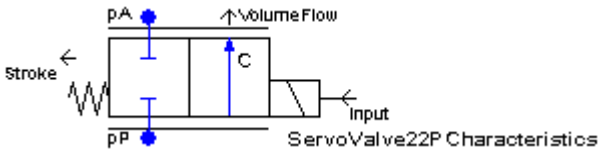
Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

The component SERVOVALVE22P does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE22PCHARACTERISTICS).

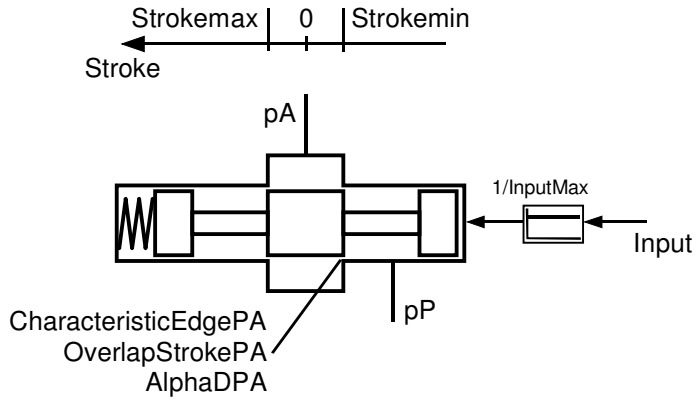
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ServoValve22PCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge

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Name	Value	Unit	Description
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
TDifference	0	K	Difference between local and system temperature

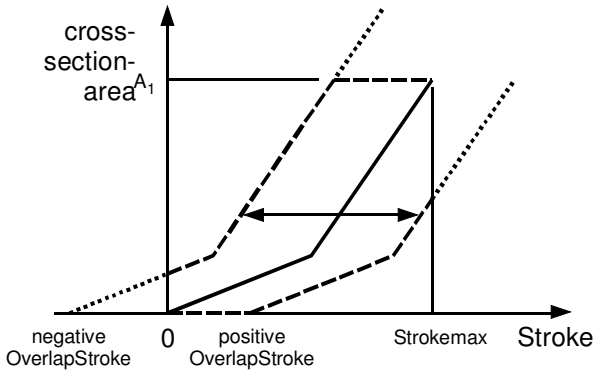
Notes

The component SERVOVALVE22PCHARACTERISTICS is a model of a 2-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position



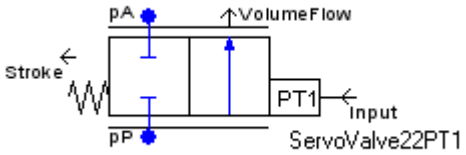
If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE22PCHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22P).

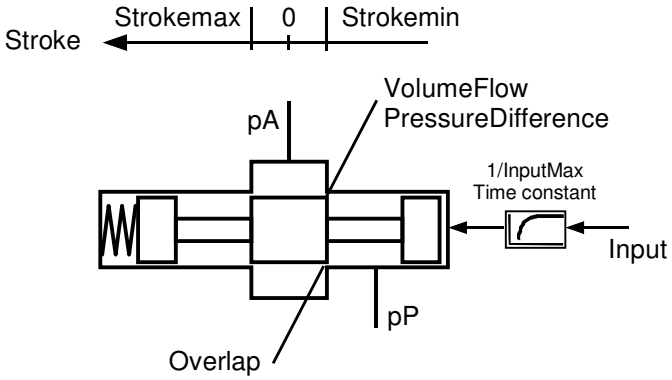
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ServoValve22PT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
T	50	ms	time constant true for: $x_{E\,n} < x_{E\,n+1}$
TDecreasing	0	ms	time constant true for: $x_{E\,n} > x_{E\,n+1}$
Strokemax	1	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	0	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edge

Notes

The component SERVOVALVE22PT1 is a model of a 2-way proportional valve at which the stroke is proportional according to a first order delay to the input signal.

It is true: TDecreasing = T , for TDecreasing = 0

The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The following rule is effective:

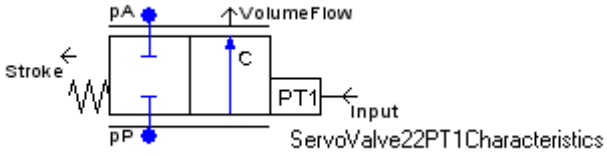
Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

The component SERVOVALVE22P does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE22PCHARACTERISTICS).

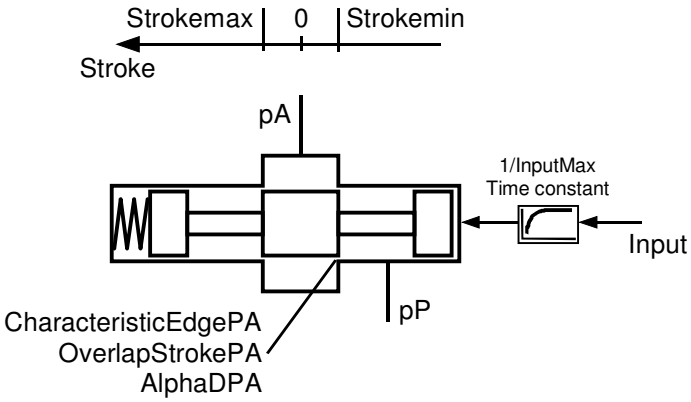
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ServoValve22PT1Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
T	50	ms	time constant true for: $x_{E\,n} < x_{E\,n+1}$
TDecreasing	0	ms	time constant true for: $x_{E\,n} > x_{E\,n+1}$

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Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
TDifference	0	K	Difference between local and system temperature

Notes

The component SERVOVALVE22PT1CHARACTERISTICS is a model of a 2-way proportional valve at which the stroke is proportional according to a first order delay to the input signal.

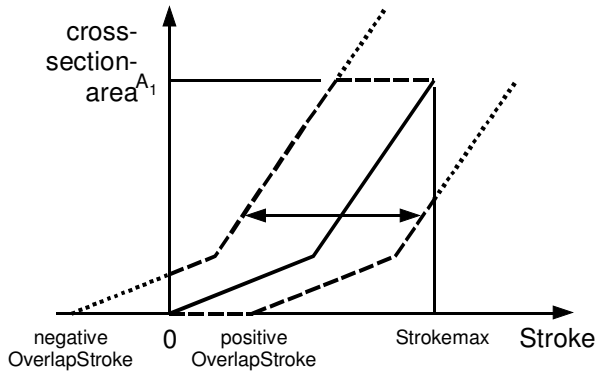
It is true: TDecreasing = T , for TDecreasing = 0

The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position



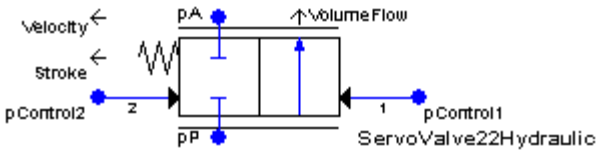
If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE22PCHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22P).

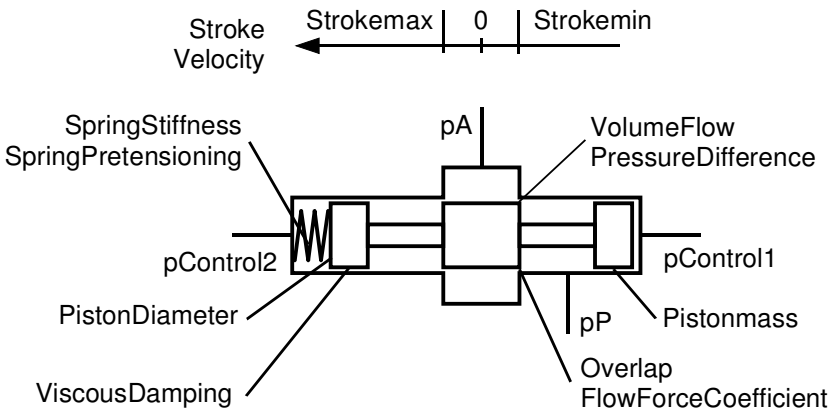
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ServoValve22Hydraulic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping

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Name	Value	Unit	Description
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
PistonMass	0.3	kg	mass of the spool
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke

Notes

The component SERVOVALVE22HYDRAULIC is a model of a 2-way proportional valve that is controlled by two hydraulic ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference,* and *Overlap*.

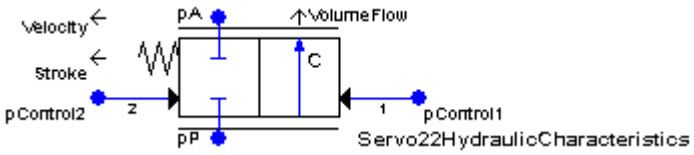
The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO22HYDRAULICCHARACTERISTICS).

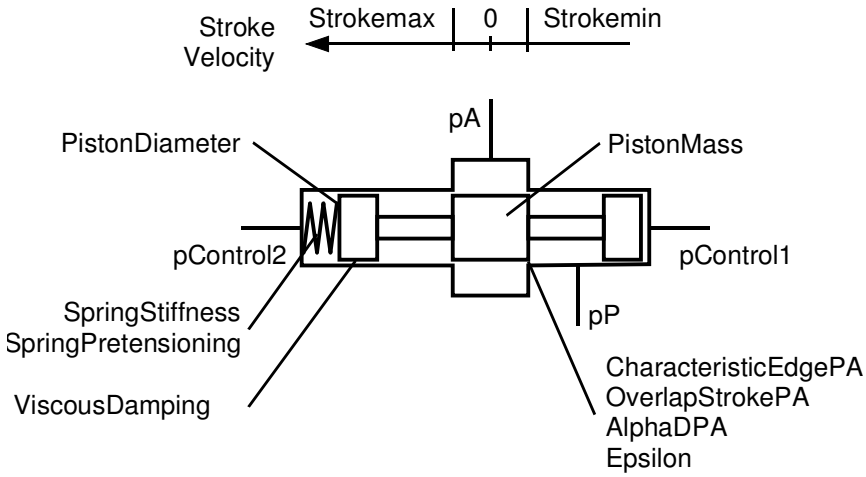
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Servo22HydraulicCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
Epsilon	60	deg	flow angle

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Name	Value	Unit	Description
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
TDifference	0	K	Difference between local and system temperature

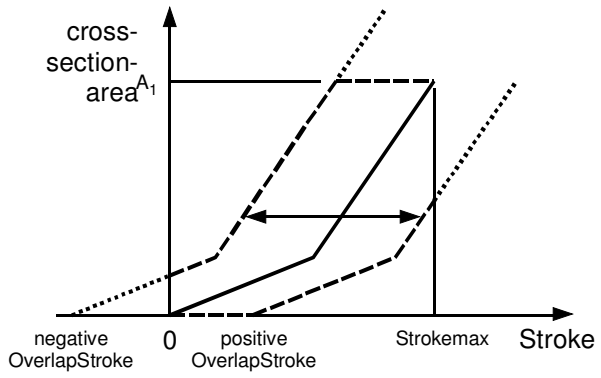
Notes

The component SERVO22HYDRAULICCHARACTERISTICS is a model of a 2-way proportional valve that is controlled by two hydraulic ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position

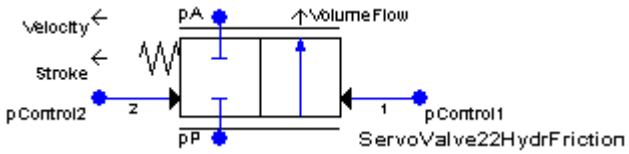


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22HYDRAULIC).

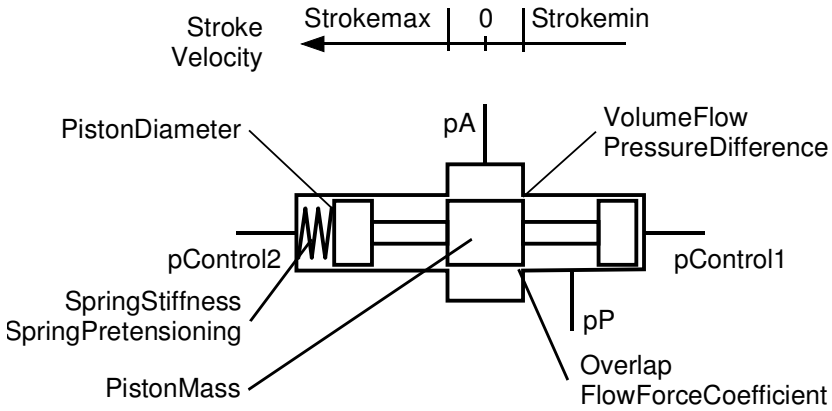
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ServoValve22HydrFriction



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	parameters for Stribeck-curve
BreakawayFrictionForce	100	N	parameters for Stribeck-curve

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Name	Value	Unit	Description
MixedFrictionForce	10	N	parameters for Stribeck-curve
SpeedMixedFriction	0.1	m/s	parameters for Stribeck-curve
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke

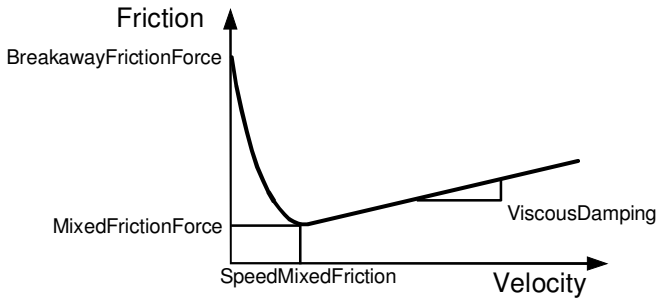
Notes

The component SERVOVALVE22HYDRFRICTION is a model of a hydraulically controlled 2-way proportional valve at which the friction between spool and hose is taken into consideration. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

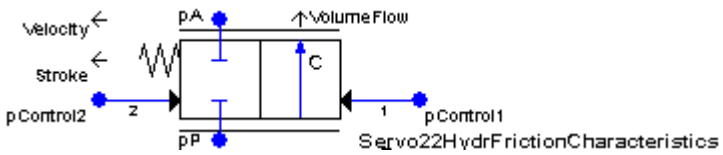
The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping* represents the characteristic values shown in the figure. The friction is independent of the pressure.



In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO22HYDRFRICTIONCHARACTERISTICS).

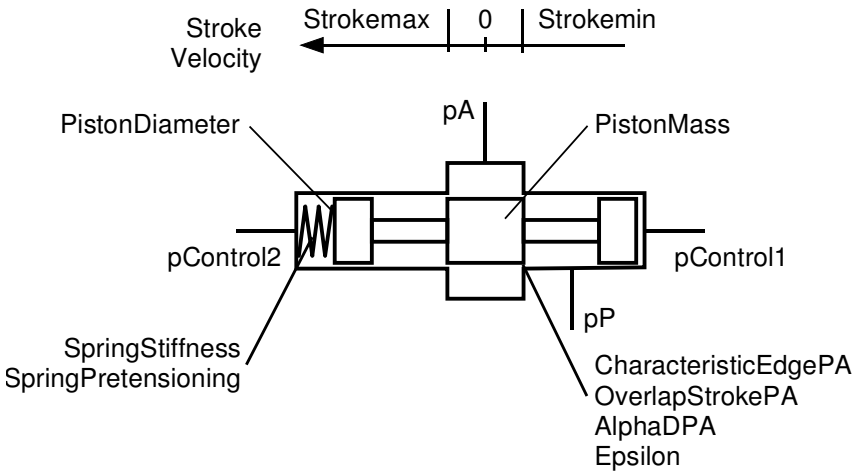
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Servo22HydrFrictionCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
Epsilon	60	deg	flow angle

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Name	Value	Unit	Description
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	parameters for Stribeck-curve
BreakawayFrictionForce	100	N	parameters for Stribeck-curve
MixedFrictionForce	10	N	parameters for Stribeck-curve
SpeedMixedFriction	0.1	m/s	parameters for Stribeck-curve
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
TDifference	0	K	Difference between local and system temperature

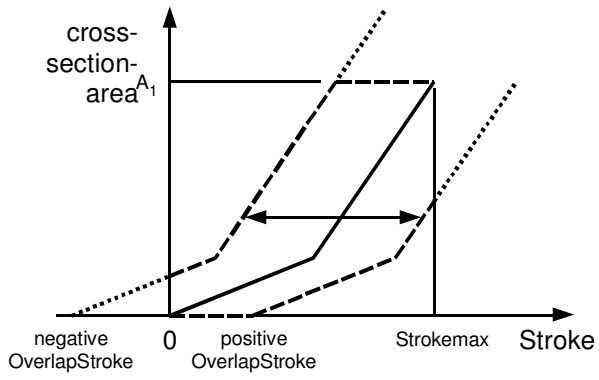
Notes

The component SERVO22HYDRFRICTIONCHARACTERISTICS is a model of a hydraulically controlled 2-way proportional valve at which the friction between spool and hose is taken into consideration. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position

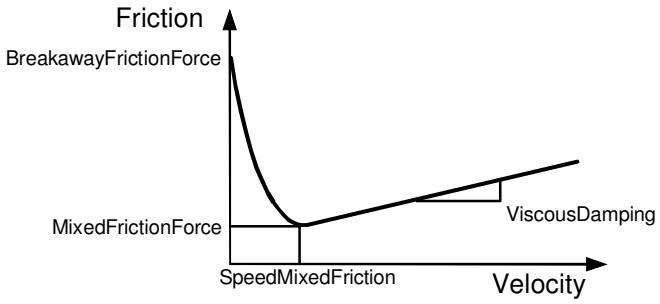


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping*

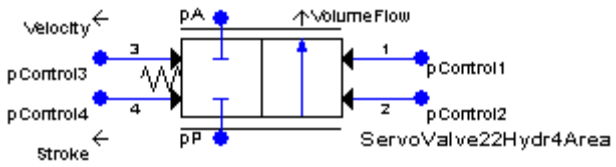
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represents the characteristic values shown in the figure. The friction is independent of the pressure.



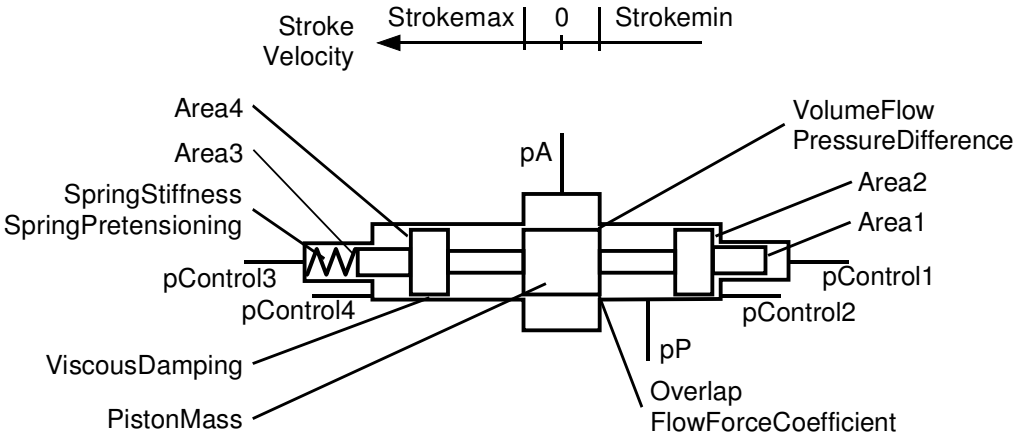
In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22HYDRFRICTION).

ServoValve22Hydr4Area



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge
Area1	80	mm²	area pressurized with *pControl1*

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Name	Value	Unit	Description
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke

Notes

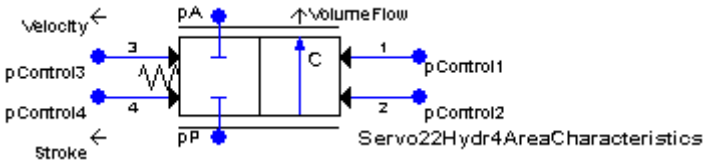
The component SERVOVALVE22HYDR4AREA is a model of a 2-way proportional valve that is controlled by four pressure ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

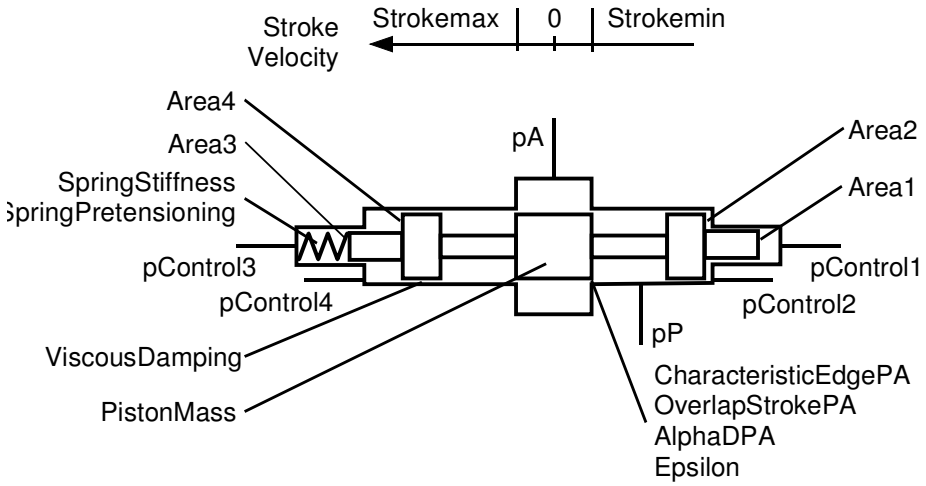
In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO22HYDR4AREACHARACTERISTICS).

Servo22Hydr4AreaCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Stroke	Out	mm	spool stroke des Dampers
Velocity	Out	m/s	spool velocity des Dampers
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge

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Name	Value	Unit	Description
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
Epsilon	60	deg	flow angle
Area1	80	mm²	area pressurized with *pControl1*
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
Tdifference	0	K	Difference between local and system temperature

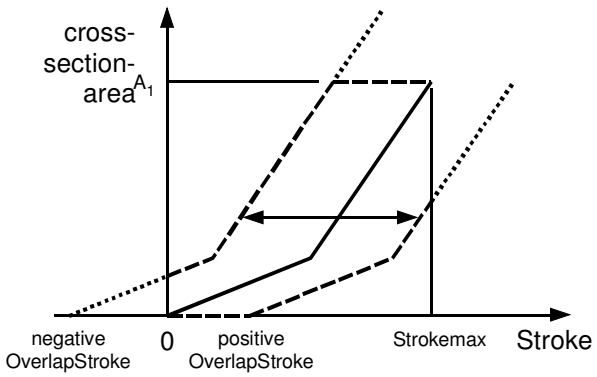
Notes

The component SERVO22HYDR4AREACHARACTERISTICS is a model of a 2-way proportional valve that is controlled by four pressure ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position

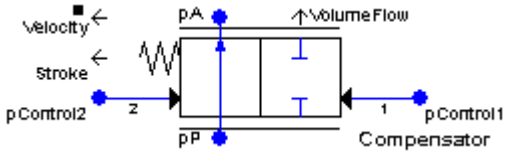


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22HYDR4AREA).

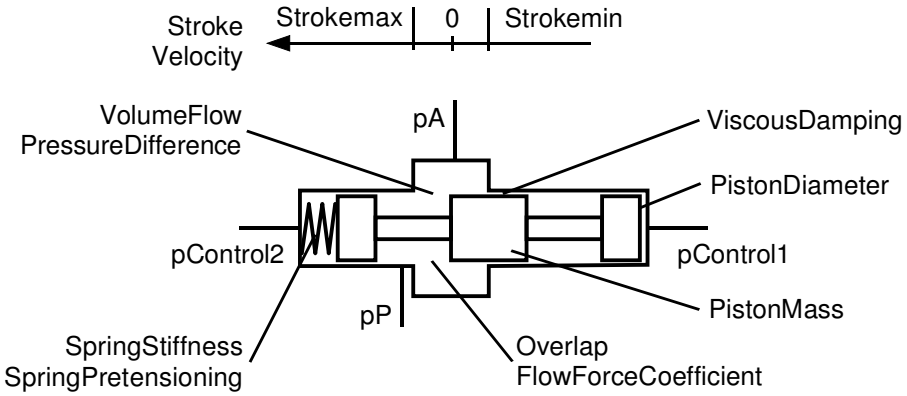
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Compensator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring

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Name	Value	Unit	Description
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke

Notes

The component COMPENSATOR is a model of a hydraulically controlled 2-way proportional valve of which the metering edge is opened in resting position. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

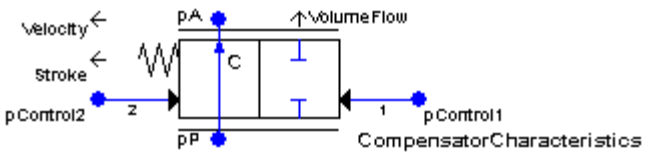
The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (COMPENSATORCHARACTERISTICS).

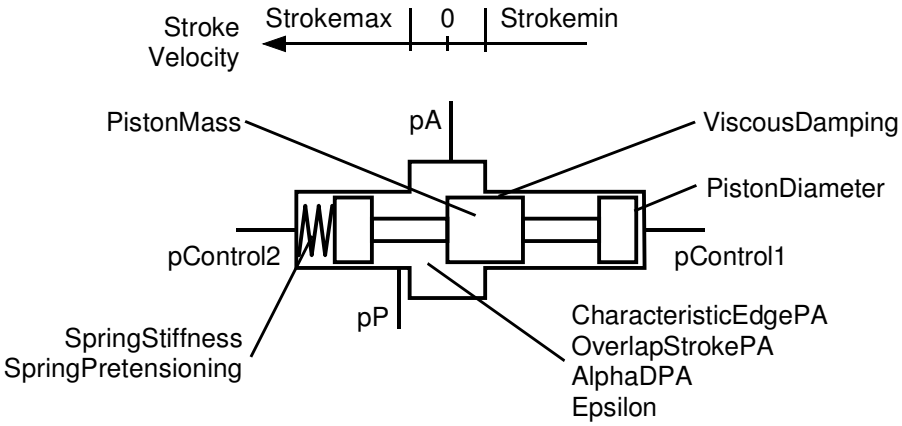
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CompensatorCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePa	0	mm	complete overlap of the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
Epsilon	60	deg	flow angle

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Name	Value	Unit	Description
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
Tdifference	0	K	Difference between local and system temperature

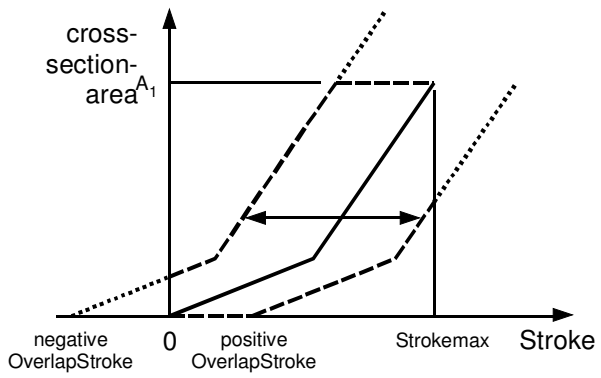
Notes

The component COMPENSATORCHARACTERISTICS is a model of a hydraulically controlled 2-way proportional valve of which the metering edge is opened in resting position. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position

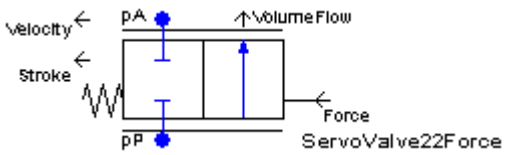


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (COMPENSATOR).

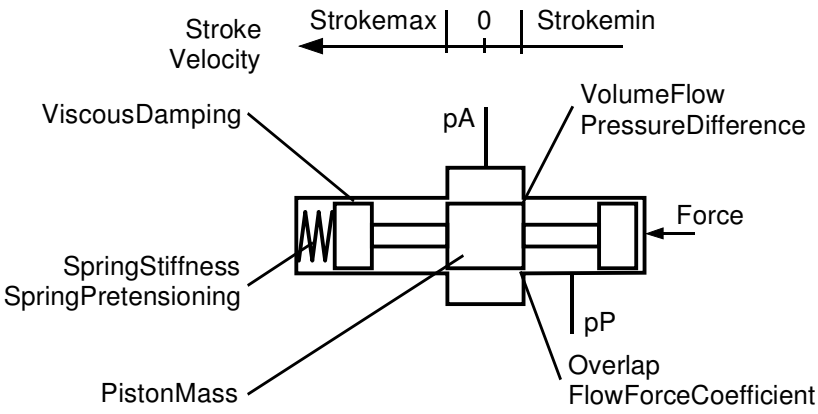
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ServoValve22Force



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston

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Name	Value	Unit	Description
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke

Notes

The component SERVOVALVE22FORCE is a model of a 2-way proportional valve that is controlled by *Force*. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

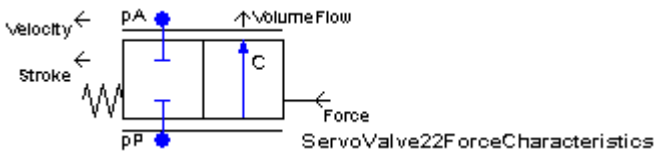
The following rule is effective:

Overlap < *0*: valve opened in resting position
Overlap = *0*: valve just closed in resting position
Overlap > *0*: valve closed in resting position

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE22FORCECHARACTERISTICS).

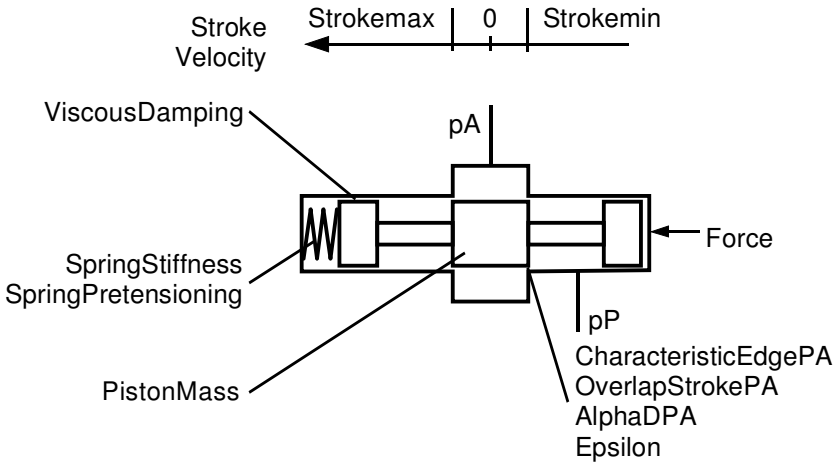
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ServoValve22ForceCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlow	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the valve
OverlapStrokePA	0	mm	complete overlap of the metering edge
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
Epsilon	60	deg	flow angle
ViscousDamping	10	Ns/m	velocity depending damping

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Name	Value	Unit	Description
SpringStiffness	50	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
PistonMass	0.3	kg	mass of the piston
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
TDifference	0	K	Difference between local and system temperature

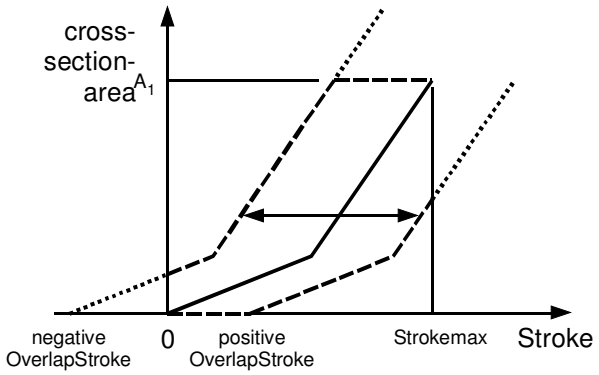
Notes

The component SERVOVALVE22FORCECHARACTERISTICS is a model of a 2-way proportional valve that is controlled by *Force*. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: valve opened in resting position
OverlapStroke = *0*: valve just closed in resting position
OverlapStroke > *0*: valve closed in resting position



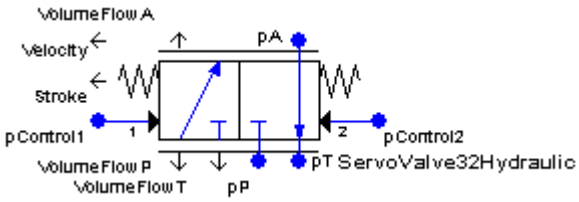
If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

In addition, a model of this 2-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE22FORCE).

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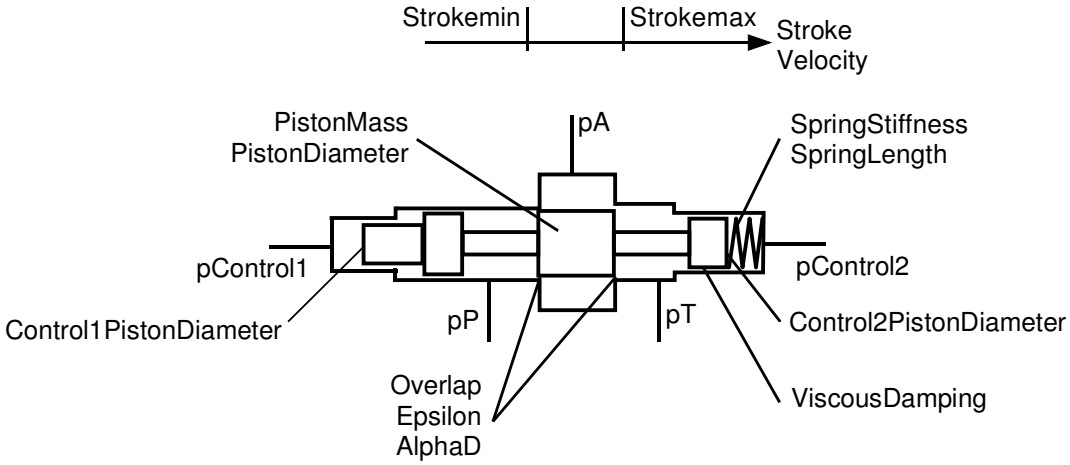
3-x Valves

ServoValve32Hydraulic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
Control1PistonDiameter	10	mm	diameter of the areas pressurized with *pControl1*
Control2PistonDiameter	10	mm	diameter of the areas pressurized with *pControl2*
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
Overlap	0	%	relative overlap of the metering edges
PistonDiameter	10	mm	diameter of the spool at the metering edge
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	20	N/mm	stiffness of the spring
SpringLength	4	mm	active spring length
PistonMass	0.4	kg	mass of the spool
Epsilon	60	deg	flow angle
AlphaD	0.6	-	flow coefficient
TDifference	0	K	Difference between local and system temperature

Notes

The component SERVOVALVE32HYDRAULIC is a model of a hydraulically controlled 2-way proportional valve with three ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

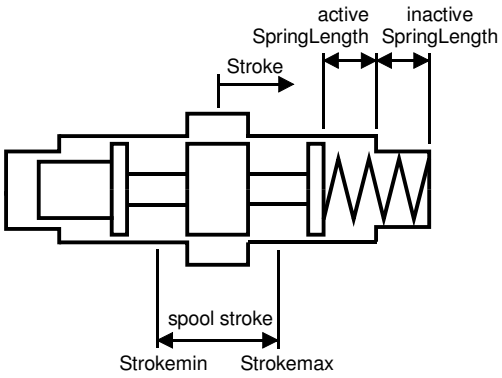
The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in transition position
Overlap = *0*: metering edges just closed in transition position
Overlap > *0*: metering edges closed in transition position

The SERVOVALVE32HYDRAULIC is in transition position at *Stroke* = (*Strokemax* - *Strokemin) / 2*. The transition position means the position between the both spool positions shown in the symbol.

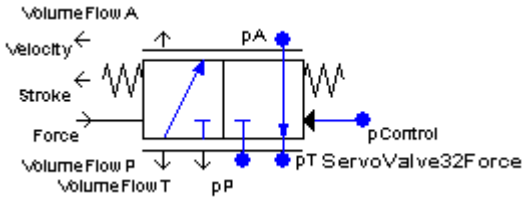
The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:

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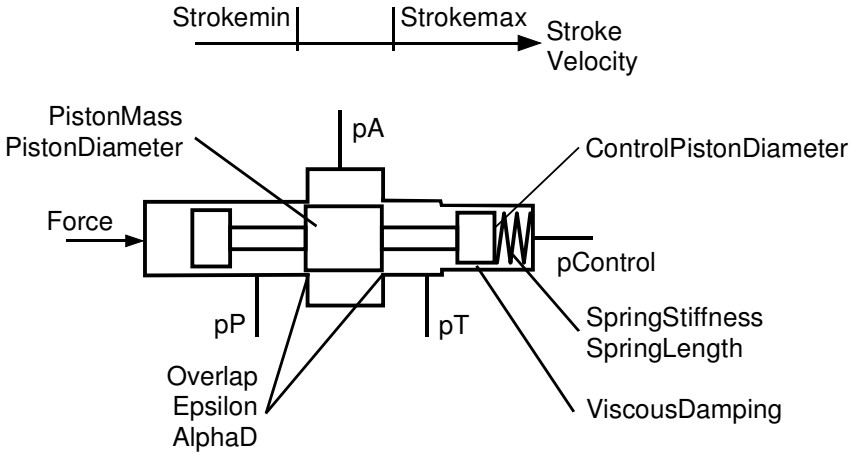
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength*) is larger than the stroke of the spool (*Strokemax - Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

ServoValve32Force



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl	Hydr	bar	control pressure
Force	In	N	force applying on the spool
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
ControlPistonDiameter	10	mm	diameter of the areas pressurized with *pControl*

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Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
Overlap	0	%	relative overlap of the metering edges
PistonDiameter	10	mm	diameter of the spool at the metering edge
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	20	N/mm	stiffness of the spring
SpringLength	4	mm	active spring length
PistonMass	0.4	kg	mass of the spool
Epsilon	60	deg	flow angle
AlphaD	0.6	-	flow coefficient
TDifference	0	K	Difference between local and system temperature

Notes

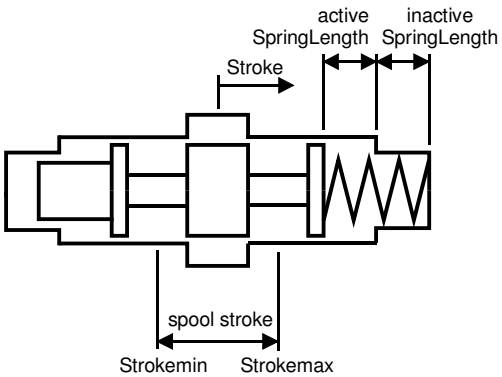
The component SERVOVALVE22FORCE is a model of a hydraulically controlled 2-way proportional valve with an additional *Force* input. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in transition position
Overlap = *0*: metering edges just closed in transition position
Overlap > *0*: metering edges closed in transition position

The SERVOVALVE32FORCE is in transition position at *Stroke* = (*Strokemax* - *Strokemin) / 2*. The transition position means the position between the both spool positions shown in the symbol.

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:

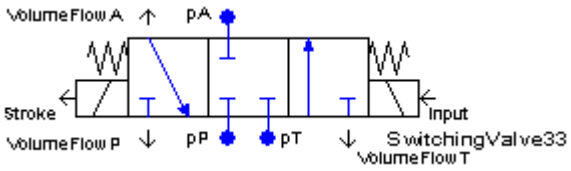


The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength*) is larger than the stroke of the spool (*Strokemax*

- *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

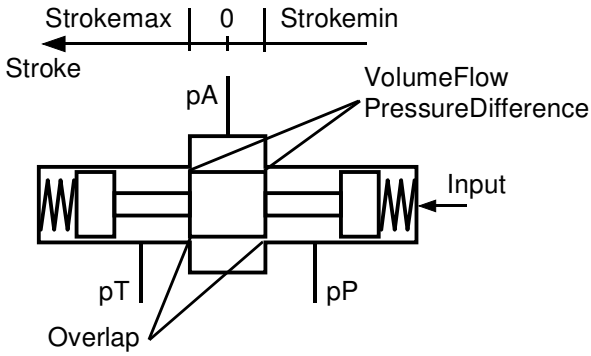
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SwitchingValve33



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edges
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

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Name	Value	Unit	Description
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve

Notes

The component SWITCHINGVALVE33 is a model of a 3-way switching. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

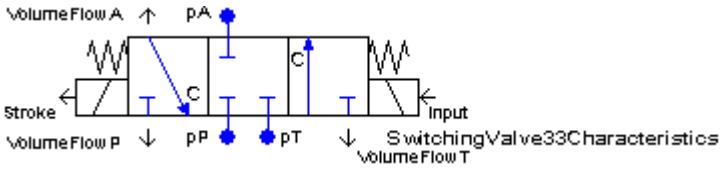
For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. At *Input* = *0* it switches into resting position. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*, i. e. the switching from one stop position to the other lasts *SwitchingTimeClose* + *SwitchingTimeOpen.*

The component SWITCHINGVALVE33 does not represent a phylical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way switching valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SWITCHINGVALVE33CHARACTERISTICS).

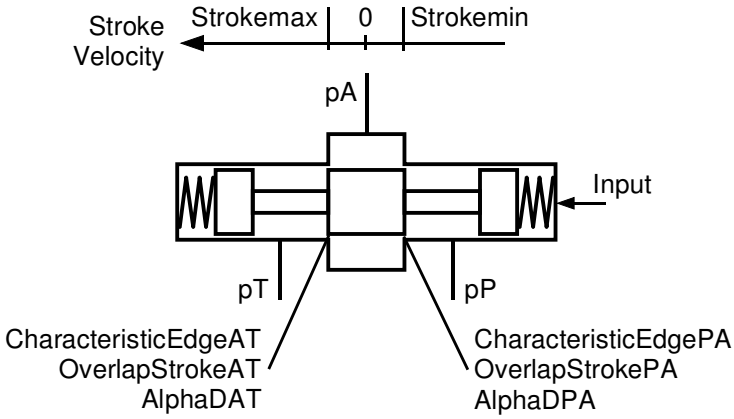
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SwitchingValve33Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
PP	Hydr	bar	supply pressure
PT	Hydr	bar	reservoir pressure
PA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T

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Name	Value	Unit	Description
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve
TDifference	0	K	Difference between local and system temperature

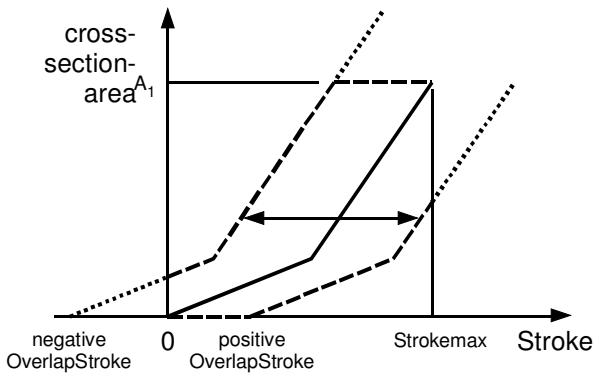
Notes

The component SWITCHINGVALVE33CHARACTERISTICS is a model of a 3-way switching. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

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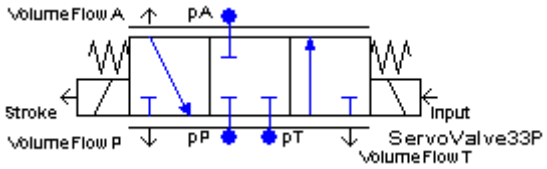
For *Input > 0* the valve switches in positive direction up to *Stroke = Strokemax*, for *Input ≤ 0* the valve switches in negative direction up to *Stroke = Strokemin*. At *Input = 0* it switches into resting position. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*, i. e. the switching from one stop position to the other lasts *SwitchingTimeClose + SwitchingTimeOpen.*

The component SWITCHINGVALVE33CHARACTERISTICS does not represent a phylical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In Modell eines 3/3-Strokee-Schaltventils steht auch als Bauteil zur Verfügung, bei dem die Durchflußcharakteristik über die Parameters *VolumeFlow* und *PressureDifference* angegeben wird (SCHALTVENTIL33).

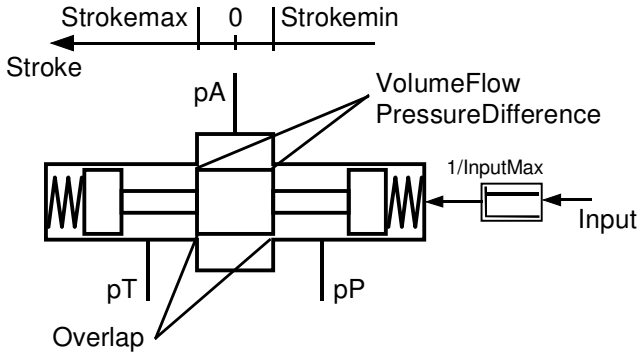
In addition, a model of this 2-way switching valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SWITCHINGVALVE33).

ServoValve33P



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke des Dampers
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

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Name	Value	Unit	Description
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges

Notes

The component SERVOVALVE33P is a model of a 3-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

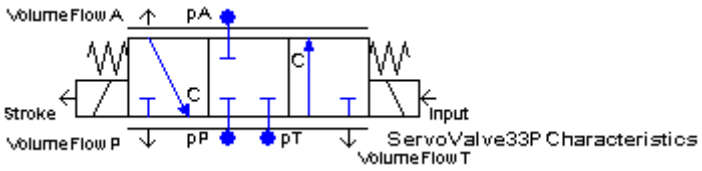
The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The component SERVOVALVE33P does not represent a phylical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

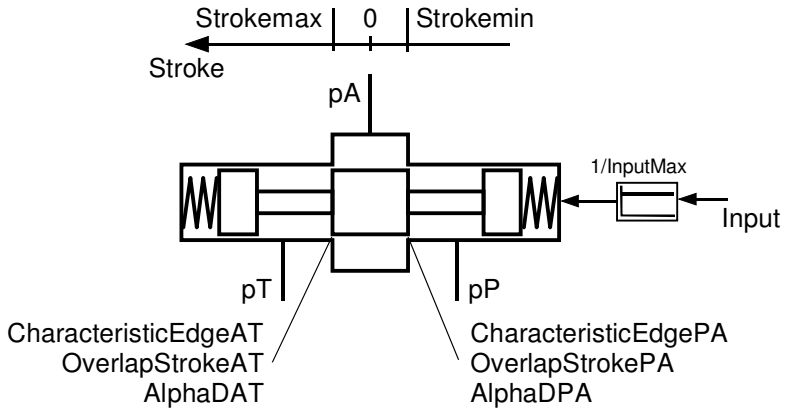
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE33PCHARACTERISTICS).

ServoValve33PCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T

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Name	Value	Unit	Description
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
TDifference	0	K	Difference between local and system temperature

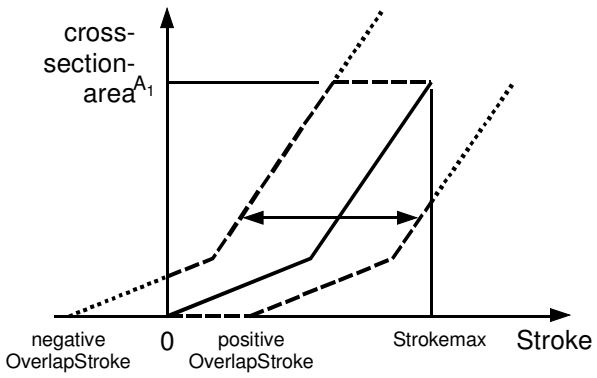
Notes

The component SERVOVALVE33PCHARACTERISTICS is a model of a 3-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



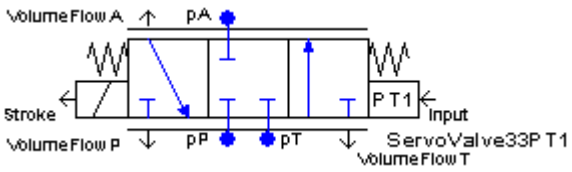
If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE33PCHARACTERISTICS does not represent a phylical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE33P).

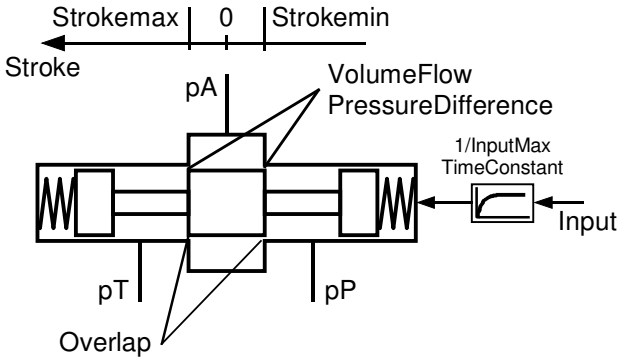
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ServoValve33PT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal

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Name	Value	Unit	Description
Overlap	0	%	relative overlap of the metering edges
TimeConstant	10	ms	parameters for control characteristics

Notes

The component SERVOVALVE33PT1 is a model of a 3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for both metering edges and it applies:

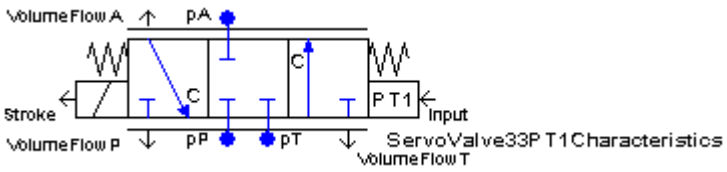
Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The component SERVOVALVE33PT1 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE33PT1CHARACTERISTICS).

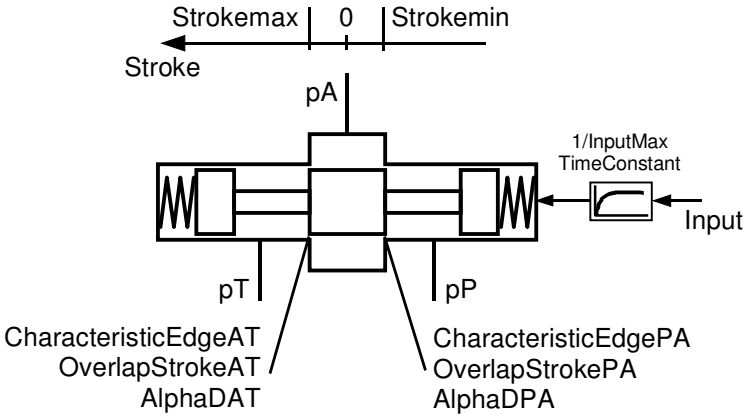
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ServoValve33PT1Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T

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Name	Value	Unit	Description
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Zeitkonstante	10	ms	parameters for control characteristics
TDifference	0	K	Difference between local and system temperature

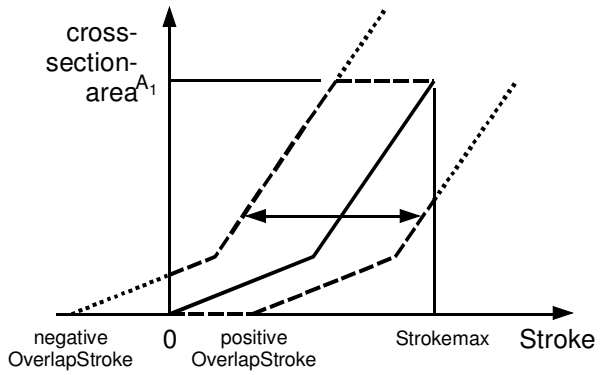
Notes

The component SERVOVALVE33PT1CHARACTERISTICS is a model of a 3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



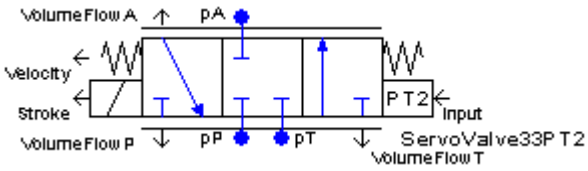
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If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE33PT1CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

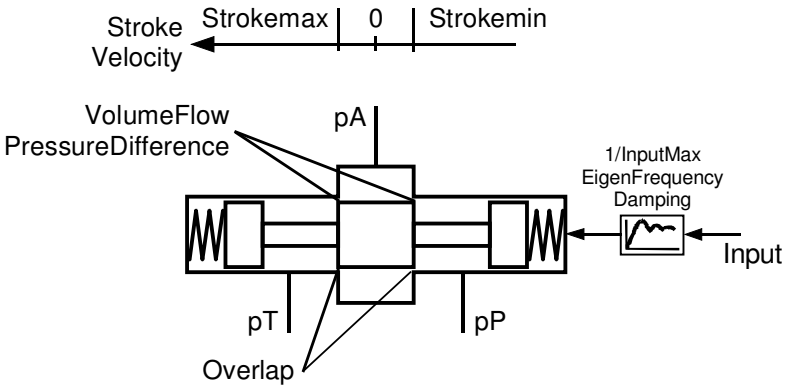
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE33PT1).

ServoValve33PT2



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

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Name	Value	Unit	Description
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges
EigenFrequency	50	Hz	parameters for control characteristics
Damping	0.7	-	parameters for control characteristics
Velocitymax	1.E99	m/s	maximum spool velocity
Velocitymin	-1.E99	m/s	maximum spool velocity in negative direction

Notes

The component SERVOVALVE33PT2 is a model of a 3-way proportional valve at which the stroke follows the input signal according to a second order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for both metering edges and it applies:

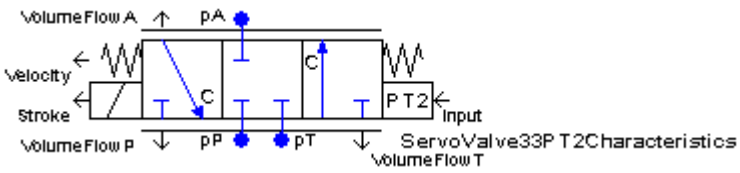
Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

In order to model a limitation of the spool velocity (e.g. in the case of limited flow through a pilot stage) the variable *Velocity* can be limited with the parameters *Velocitymax* and *Velocitymin*. With these parameters set to ±1E99 1/s, the velocity can be considered as unlimited.

The component SERVOVALVE33PT2 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

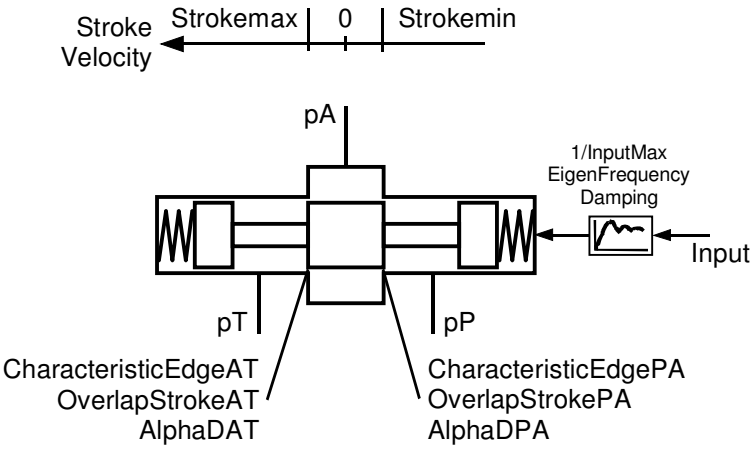
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE33PT2CHARACTERISTICS).

ServoValve33PT2Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Input	In	-	input signal for the spool stroke
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T

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Name	Value	Unit	Description
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization for the input signal
EigenFrequency	50	Hz	parameters for control characteristics
Damping	0.7	-	parameters for control characteristics
Velocitymax	1.E99	m/s	maximum spool velocity
Velocitymin	-1.E99	m/s	maximum spool velocity in negative direction
TDifference	0	K	Difference between local and system temperature

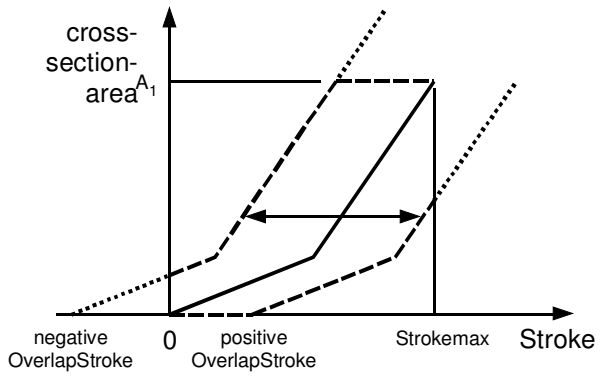
Notes

The component SERVOVALVE33PT2CHARACTERISTICS is a model of a 3-way proportional valve at which the stroke follows the input signal according to a second order delay. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

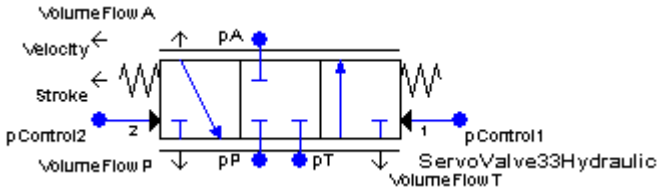
In order to model a limitation of the spool velocity (e.g. in the case of limited flow through a pilot stage) the variable *Velocity* can be limited with the parameters *Velocitymax* and *Velocitymin*. With these parameters set to ±1E99 1/s, the velocity can be considered as unlimited.

The component SERVOVALVE33PT2CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE33PT2).

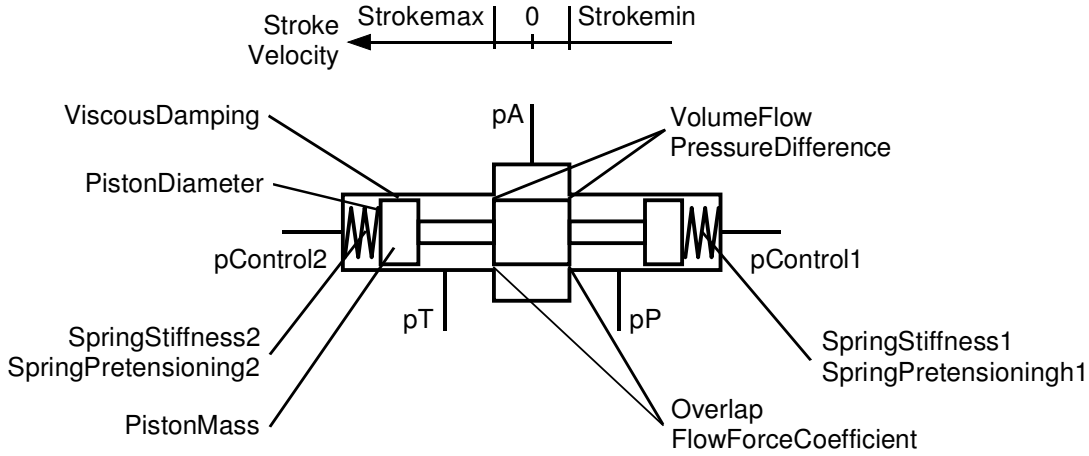
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ServoValve33Hydraulic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above

Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Overlap	0	%	relative overlap of the metering edges
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of return spring 1
SpringPretensioning1	2	mm	pretensioning of return spring 1
SpringStiffness2	20	N/mm	stiffness of return spring 2
SpringPretensioning2	2	mm	pretensioning of return spring 2
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
PistonMass	0.4	kg	mass of the spool

Notes

The component SERVOVALVE33HYDRAULIC is a model of a hydraulically controlled 3-way proportional valve. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

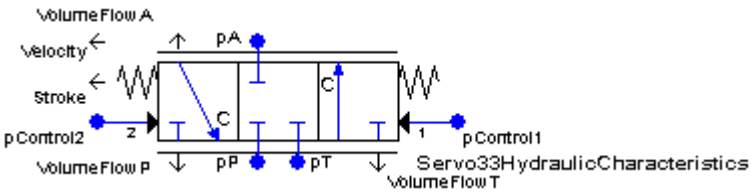
The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO33HYDRAULICCHARACTERISTICS).

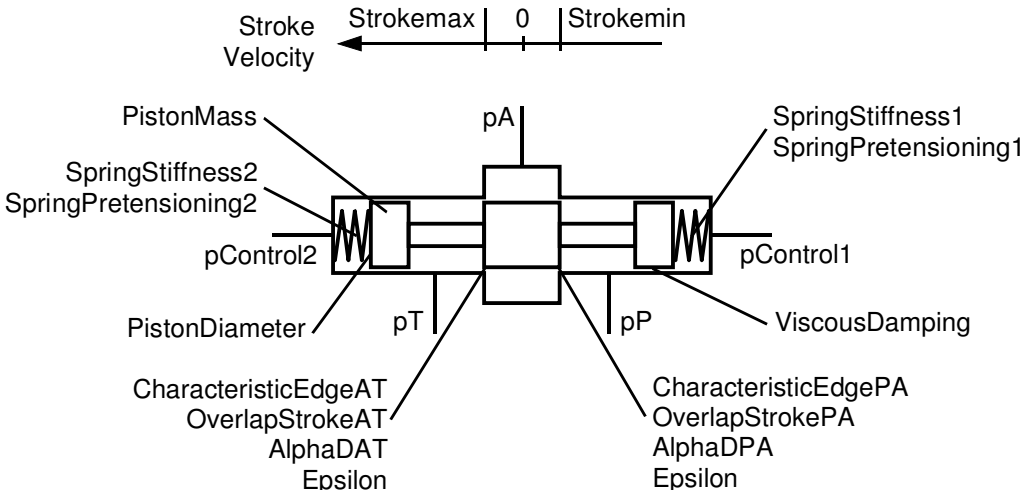
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Servo33HydraulicCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A

Name	Value	Unit	Description
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Epsilon	60	deg	flow angle
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of return spring 1
SpringPretensioning1	2	mm	pretensioning of return spring 1
SpringStiffness2	20	N/mm	stiffness of return spring 2
SpringPretensioning2	2	mm	pretensioning of return spring 2
PistonMass	0.4	kg	mass of the spool
TDifference	0	K	Difference between local and system temperature

Notes

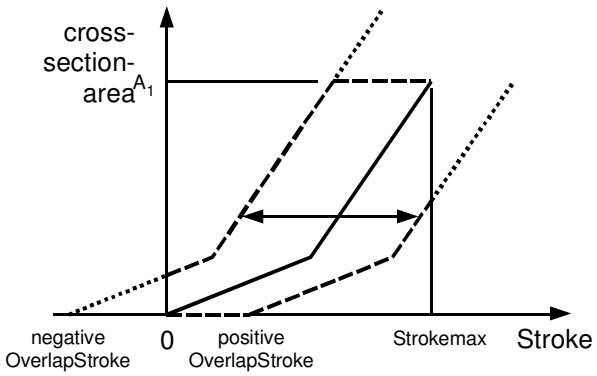
The component SERVO33HYDRAULICCHARACTERISTICS is a model of a hydraulically controlled 3-way proportional valve. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position

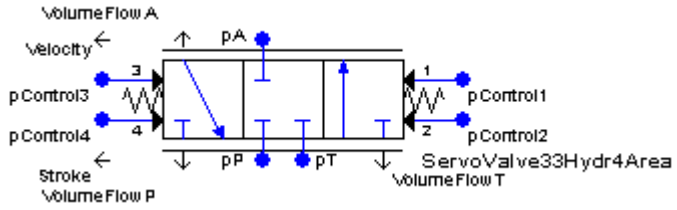
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If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

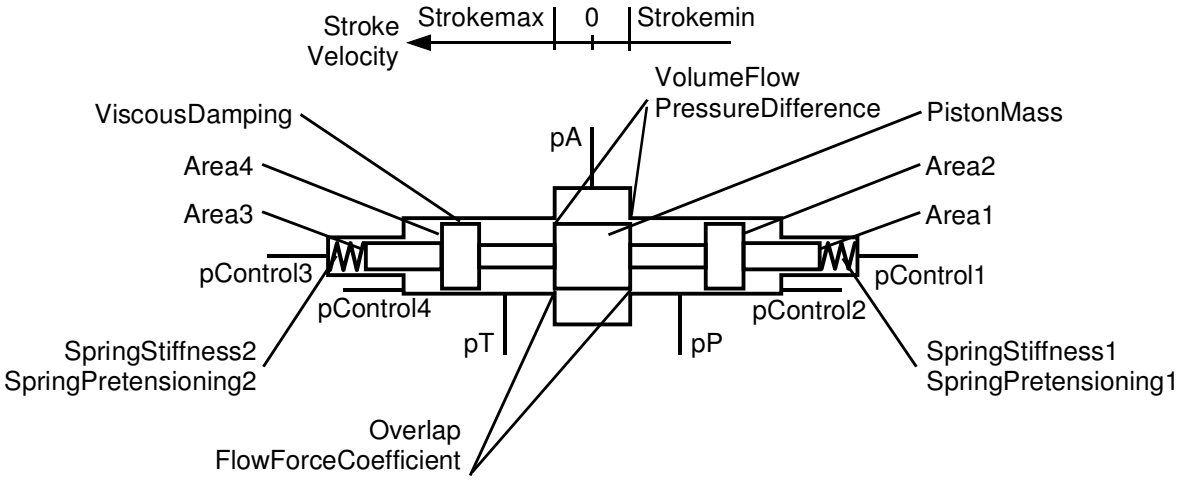
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE33HYDRAULIC).

ServoValve33Hydr4Area



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Overlap	0	%	relative overlap of the metering edges
Area1	80	mm²	area pressurized with *pControl1*
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of return spring 1
SpringPretensioning1	2	mm	pretensioning of return spring 1
SpringStiffness2	20	N/mm	stiffness of return spring 2
SpringPretensioning2	2	mm	pretensioning of return spring 2
PistonMass	0.4	kg	mass of the spool
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation

Notes

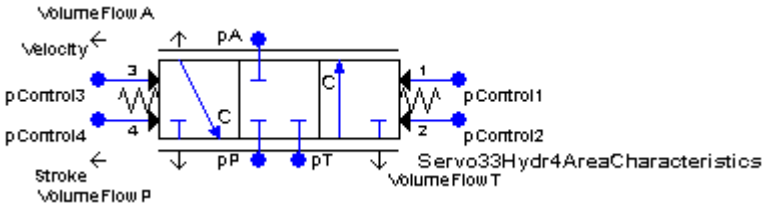
The component SERVOVALVE33HYDR4AREA is a model of a 3-way proportional valve that is controlled by four pressure ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

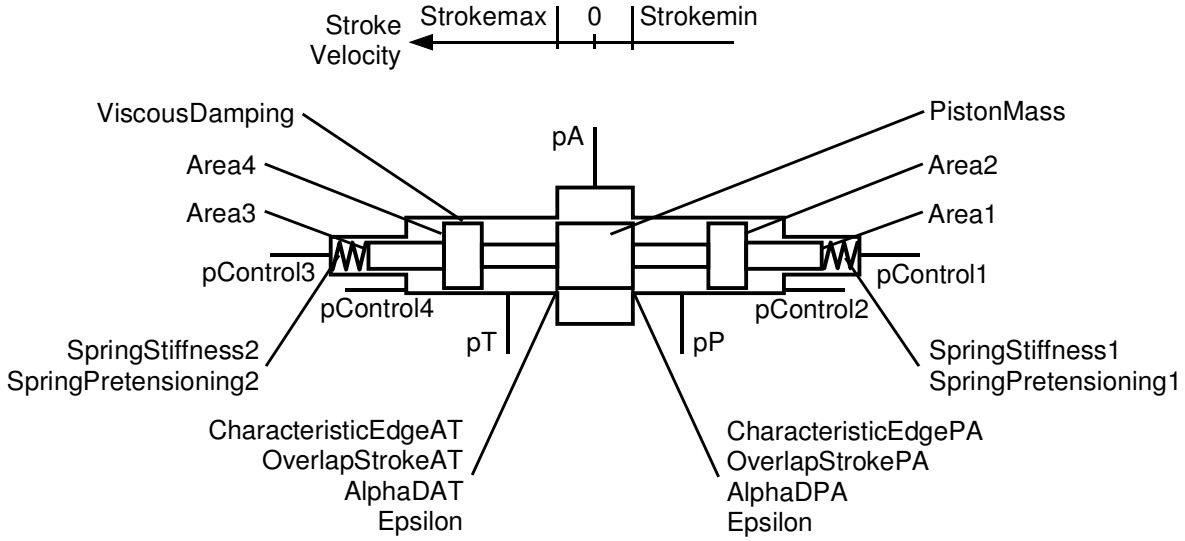
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO33HYDR4AREACHARACTERISTICS).

Servo33Hydr4AreaCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

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Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
Epsilon	60	deg	flow angle
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Area1	80	mm²	area pressurized with *pControl1*
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of return spring 1
SpringPretensioning1	2	mm	pretensioning of return spring 1
SpringStiffness2	20	N/mm	stiffness of return spring 2
SpringPretensioning2	2	mm	pretensioning of return spring 2
PistonMass	0.4	kg	mass of the spool
TDifference	0	K	Difference between local and system temperature

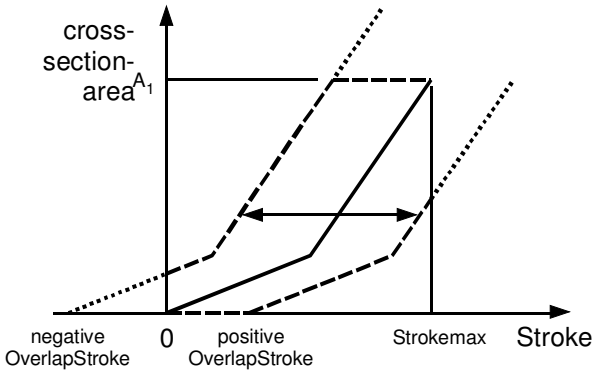
Notes

The component SERVO33HYDR4AREACHARACTERISTICS is a model of a 3-way proportional valve that is controlled by four pressure ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position

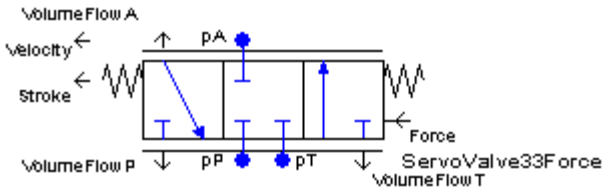


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE33HYDR4AREA).

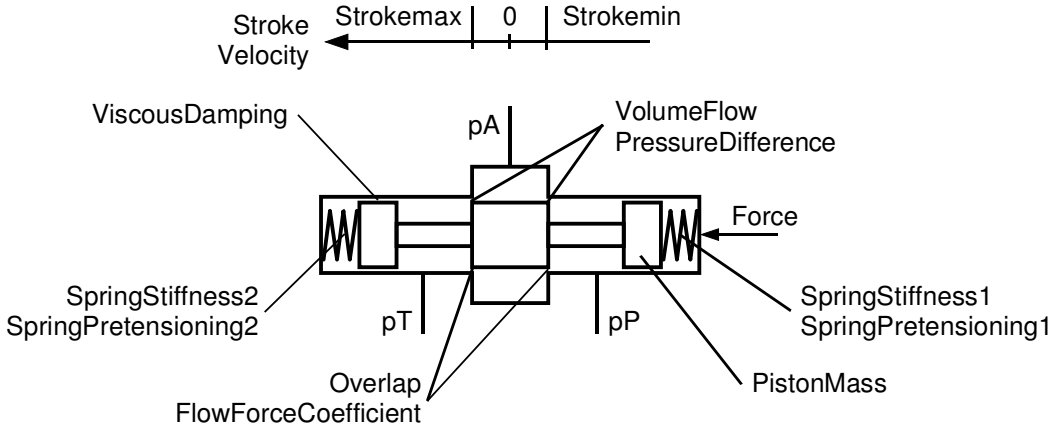
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ServoValve33Force



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure
Force	In	N	force applying on the spool
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edge

Name	Value	Unit	Description
ViscousDamping	1	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of return spring 1
SpringPretensioning1	2	mm	pretensioning of return spring 1
SpringStiffness2	20	N/mm	stiffness of return spring 2
SpringPretensioning2	2	mm	pretensioning of return spring 2
PistonMass	0.4	kg	mass of the spool
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

Notes

The component SERVOVALVE33FORCE is a model of a 3-way proportional valve that is controlled by *Force*. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

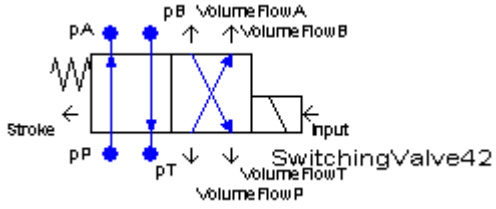
The overlap is the same for both metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

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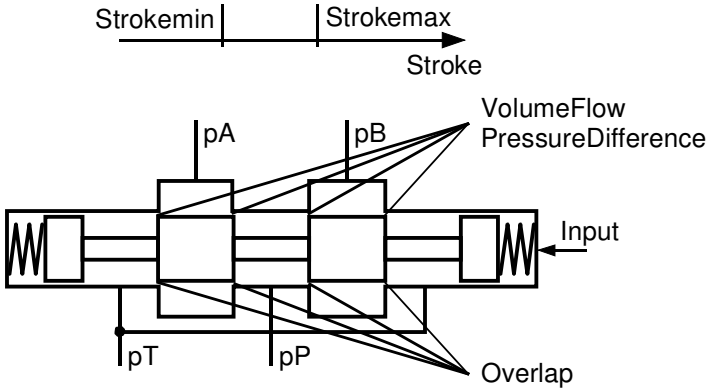
4-x Valves

SwitchingValve42



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow
VolumeFlowT	Out	l/min	volume flow
VolumeFlowA	Out	l/min	volume flow
VolumeFlowB	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above

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Name	Value	Unit	Description
Overlap	0	%	relative overlap of the metering edges
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve

Notes

The component SWITCHINGVALVE42 is a model of a 4-way switching valve with four ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

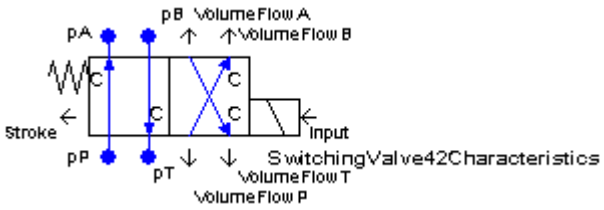
For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*.

The component SWITCHINGVALVE42 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 4/2-way switching valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SWITCHINGVALVE42CHARACTERISTICS).

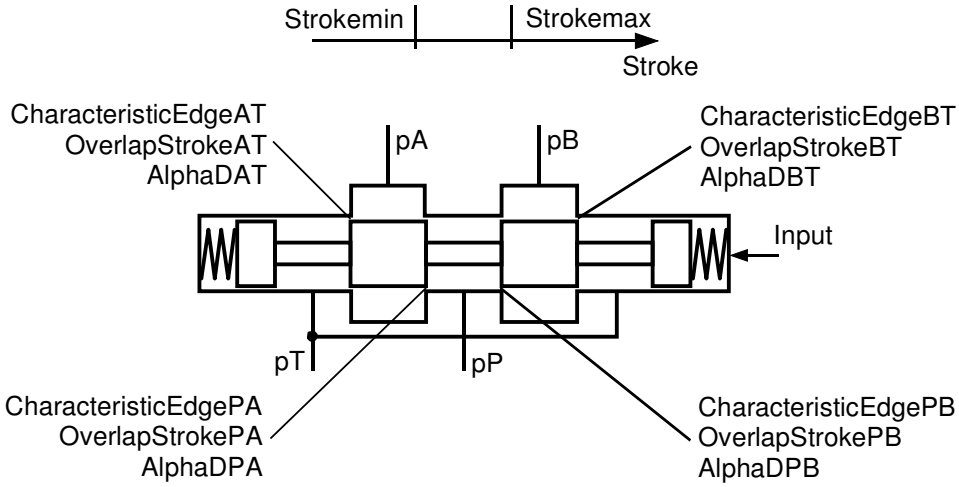
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SwitchingValve42Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow
VolumeFlowT	Out	l/min	volume flow
VolumeFlowA	Out	l/min	volume flow
VolumeFlowB	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A

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Name	Value	Unit	Description
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve
TDifference	0	K	Difference between local and system temperature

Notes

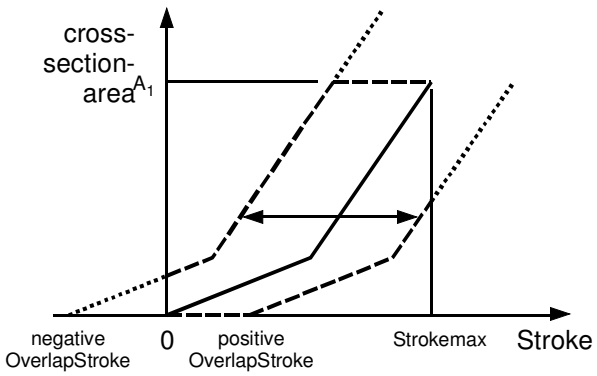
The component SWITCHINGVALVE42CHARACTERISTICS is a model of a 4-way switching valve with four ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

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It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



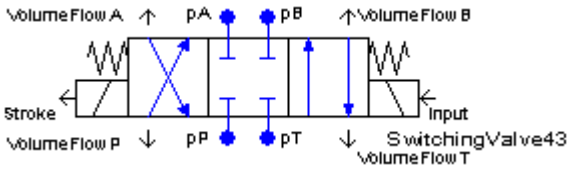
If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*.

The component SWITCHINGVALVE42CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

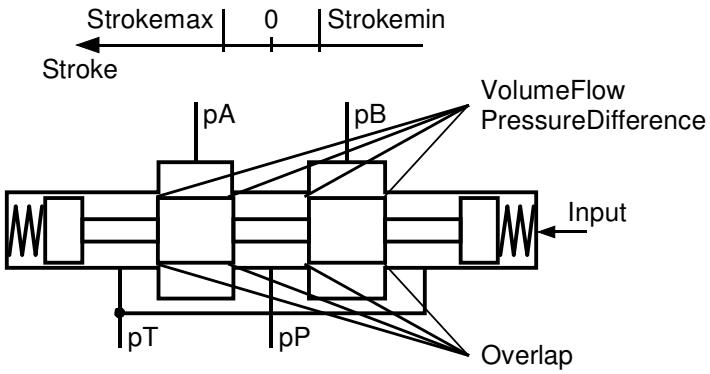
In addition, a model of this 4/2-way switching valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SWITCHINGVALVE42).

SwitchingValve43



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow
VolumeFlowT	Out	l/min	volume flow
VolumeFlowA	Out	l/min	volume flow
VolumeFlowB	Out	l/min	volume flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edges

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Name	Value	Unit	Description
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve

Notes

The component SWITCHINGVALVE43 is a model of a 3-way switching valve with four ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

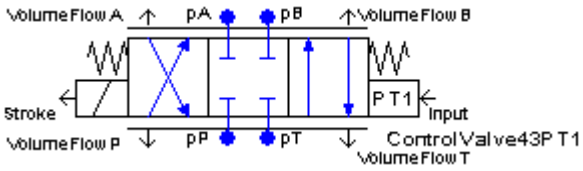
Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

For *Input* > *0* the valve switches in positive direction up to *Stroke* = *Strokemax*, for *Input* ≤ *0* the valve switches in negative direction up to *Stroke* = *Strokemin*. At *Input* = *0* it switches into resting position. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*, i. e. the switching from one stop position to the other lasts *SwitchingTimeClose* + *SwitchingTimeOpen.*

The component SWITCHINGVALVE43 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

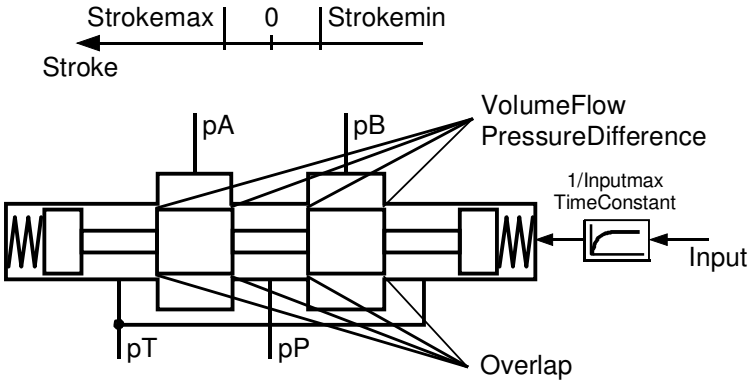
In addition, a model of this 4/3-way switching valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SWITCHINGVALVE43CHARACTERISTICS).

ControlValve43PT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges
TimeConstant	10	ms	parameters for control characteristics
Q_Kink	10	%	see notes
Stroke_Kink	20	%	see notes

Notes

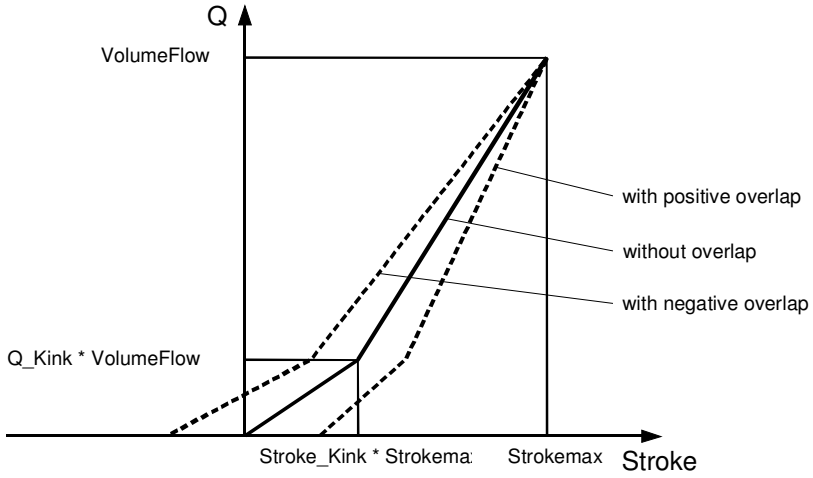
The component CONTROLVALVE43PT1 is a model of a 3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

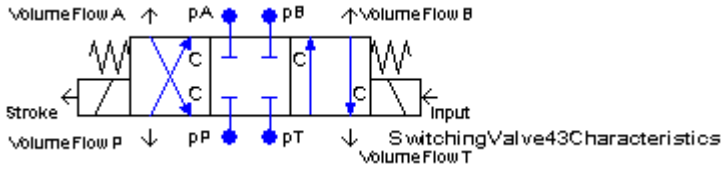
Overlap < 0: metering edges opened in resting position
Overlap = 0: metering edges just closed in resting position
Overlap > 0: metering edges closed in resting position

The component CONTROLVALVE43PT1 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

The parameters *Q_Kink* and *Stroke_Kink* allows to determine a fine control range. The following figure shows the flow-stroke function:

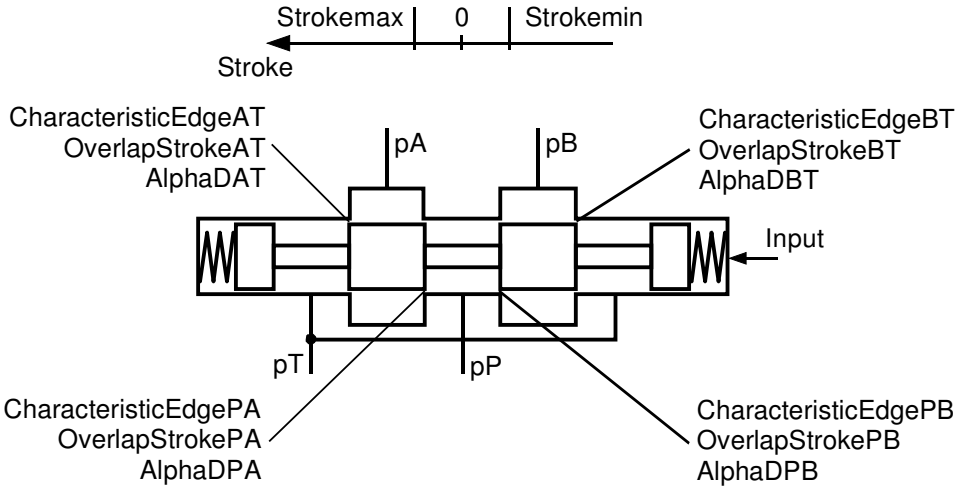


SwitchingValve43Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the of the metering edge from P to A

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Name	Value	Unit	Description
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
SwitchingTimeOpen	3	ms	time for the opening motion
SwitchingTimeClose	3	ms	time for the closing motion
SwitchingThreshold	0	-	Value of the input signal to open the valve
TDifference	0	K	Difference between local and system temperature

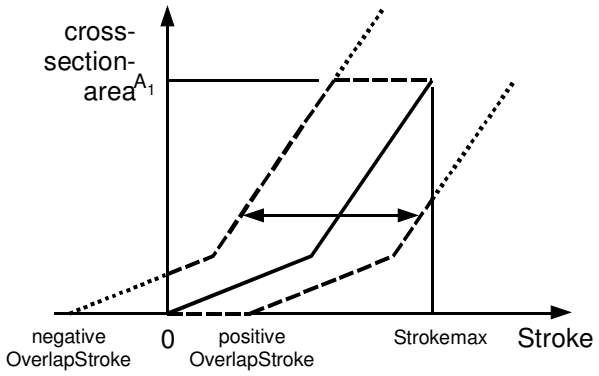
Notes

The component SWITCHINGVALVE43CHARACTERISTICS is a model of a 3-way switching valve with four ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

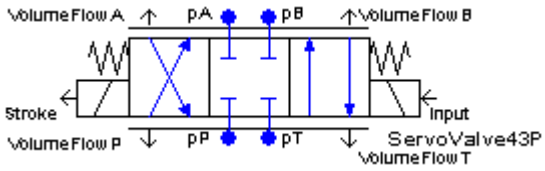
For *Input > 0* the valve switches in positive direction up to *Stroke = Strokemax*, for *Input ≤ 0* the valve switches in negative direction up to *Stroke = Strokemin*. At *Input = 0* it switches into resting position. The opening of the valve lasts always *SwitchingTimeOpen*, the closing always *SwitchingTimeClose*, i. e. the switching from one stop position to the other lasts *SwitchingTimeClose + SwitchingTimeOpen.*

The component SWITCHINGVALVE43CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 4/3-way switching valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SWITCHINGVALVE43).

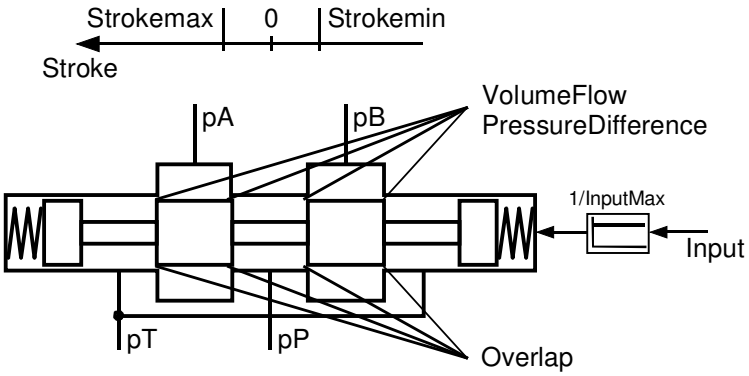
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ServoValve43P



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges

Notes

The component SERVOVALVE43P is a model of a 3-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

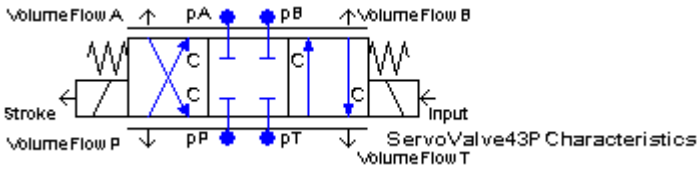
Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The component SERVOVALVE43P does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE43PCHARACTERISTICS).

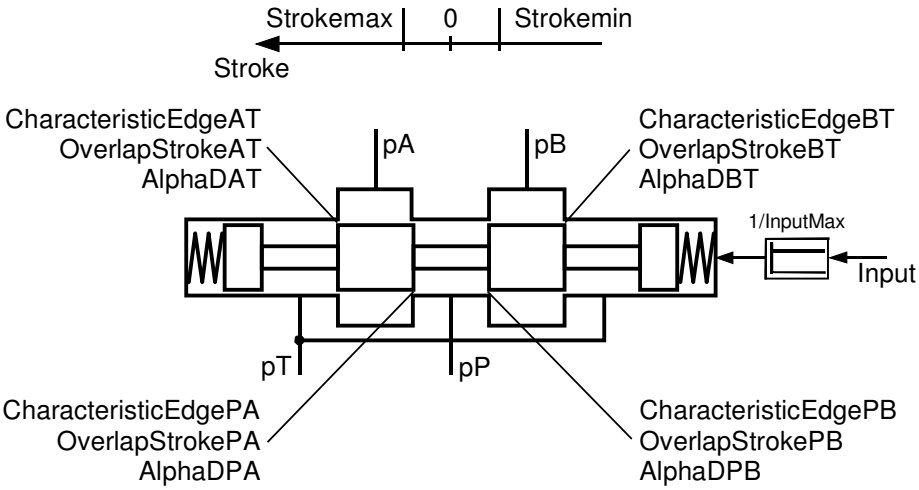
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ServoValve43PCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A

Name	Value	Unit	Description
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
TDifference	0	K	Difference between local and system temperature

Notes

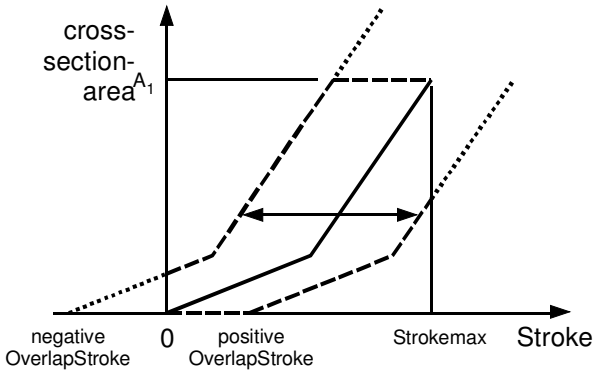
The component SERVOVALVE43PCHARACTERISTICS is a model of a 3-way proportional valve at which the stroke is proportional to the input signal. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

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OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position

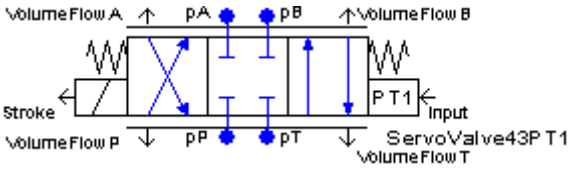


If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE43PCHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

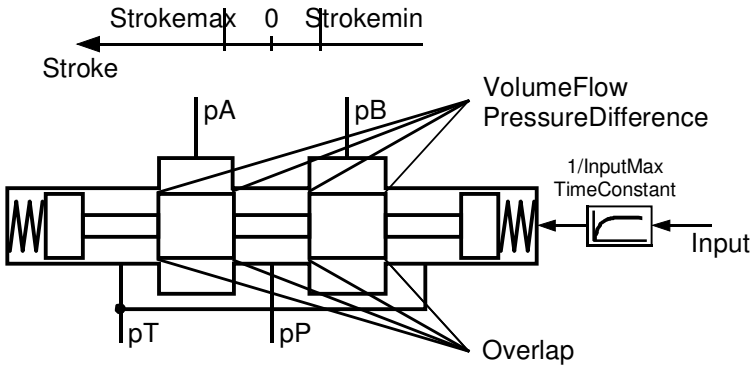
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43P).

ServoValve43PT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges
TimeConstant	10	ms	parameters for control characteristics

Notes

The component SERVOVALVE43PT1 is a model of a 3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

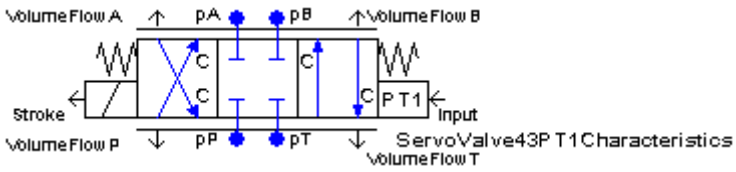
The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The component SERVOVALVE43PT1 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

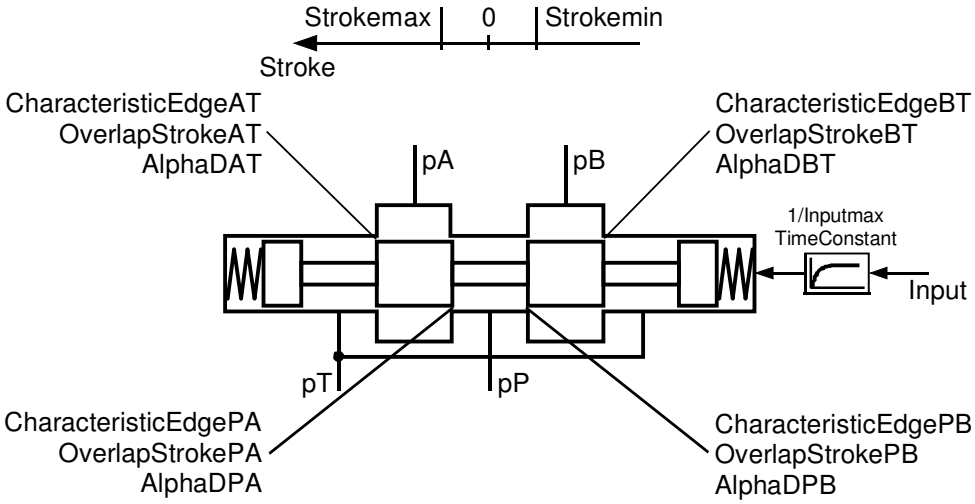
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE43PT1CHARACTERISTICS).

ServoValve43PT1Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A

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Name	Value	Unit	Description
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
TimeConstant	10	ms	parameters for control characteristics
TDifference	0	K	Difference between local and system temperature

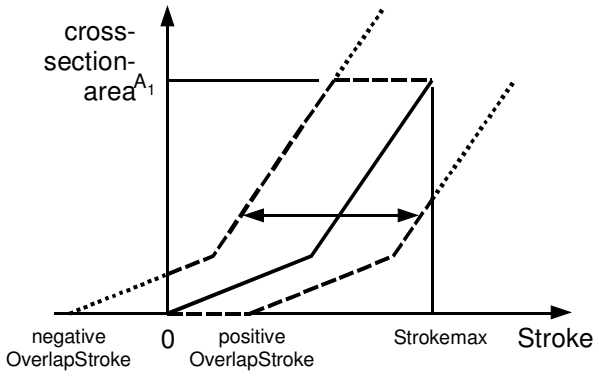
Notes

The component SERVOVALVE43PT1CHARACTERISTICS is a model of a 3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



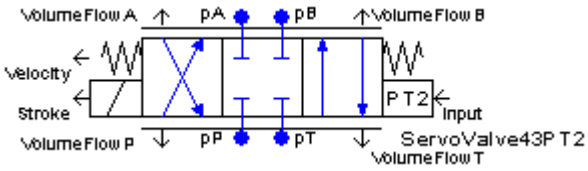
If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE43PT1CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43PT1).

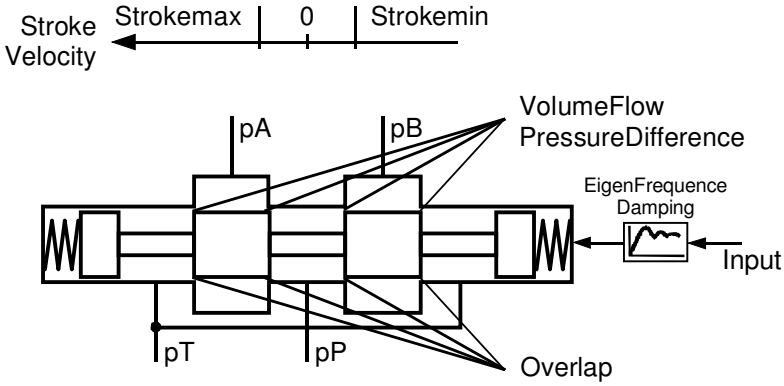
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ServoValve43PT2



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Strokemax	1	mm	maximum spool stroke for a positive stroke

Name	Value	Unit	Description
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
Overlap	0	%	relative overlap of the metering edges
EigenFrequency	50	Hz	parameters for control characteristics
Damping	0.7	-	parameters for control characteristics
Velocitymax	1E99	m/s	maximum spool velocity
Velocitymin	-1E99	m/s	maximum spool velocity in negative direction

Notes

The component SERVOVALVE43PT2 is a model of a 3-way proportional valve at which the stroke follows the input signal according to a second order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

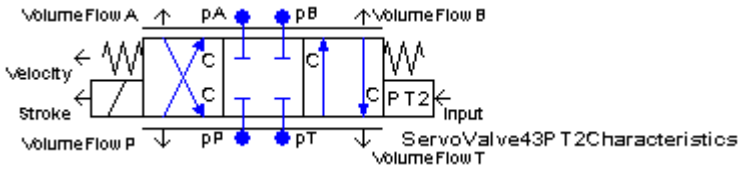
The component SERVOVALVE43PT2 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In order to model a limitation of the spool velocity (e.g. in the case of limited flow through a pilot stage) the variable *Velocity* can be limited with the parameters *Velocitymax* and *Velocitymin*. With these parameters set to ±1E99 1/s, the velocity can be considered as unlimited.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE43PT2CHARACTERISTICS).

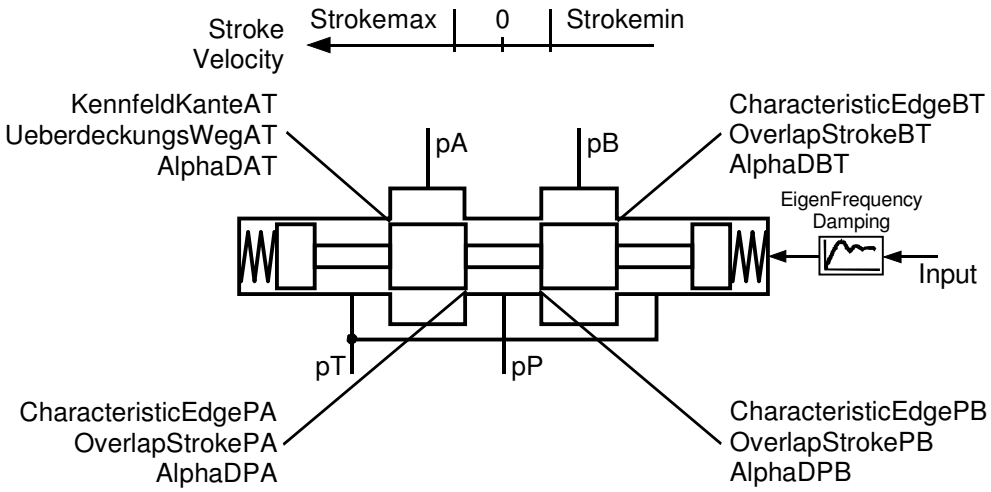
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ServoValve43PT2Characteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Input	In	-	input signal for the spool stroke
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	Mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
InputMax	1	-	standardization parameters for the input signal
EigenFrequency	50	Hz	parameters for control characteristics
Damping	0.7	-	parameters for control characteristics
Velocitymax	1E99	m/s	maximum spool velocity

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Name	Value	Unit	Description
Velocitymin	-1E99	m/s	maximum spool velocity in negative direction
TDifference	0	K	Difference between local and system temperature

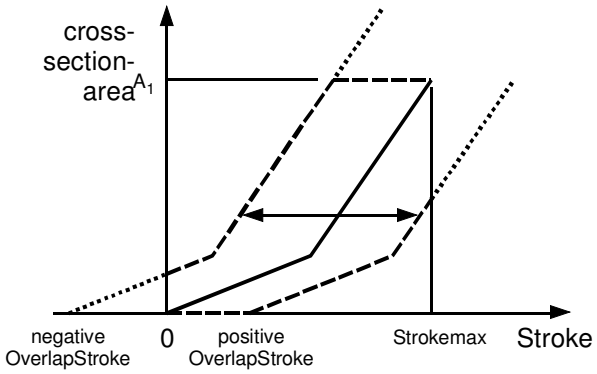
Notes

The component SERVOVALVE43PT2CHARACTERISTICS is a model of a 3-way proportional valve at which the stroke follows the input signal according to a second order delay. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



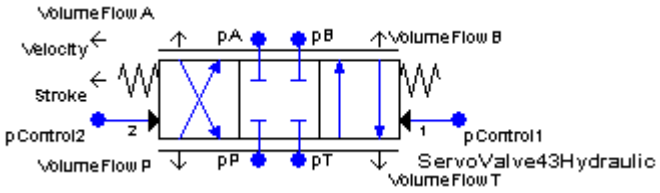
If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component SERVOVALVE43PT2CHARACTERISTICS does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized.

In order to model a limitation of the spool velocity (e.g. in the case of limited flow through a pilot stage) the variable *Velocity* can be limited with the parameters *Velocitymax* and *Velocitymin*. With these parameters set to ±1E99 1/s, the velocity can be considered as unlimited.

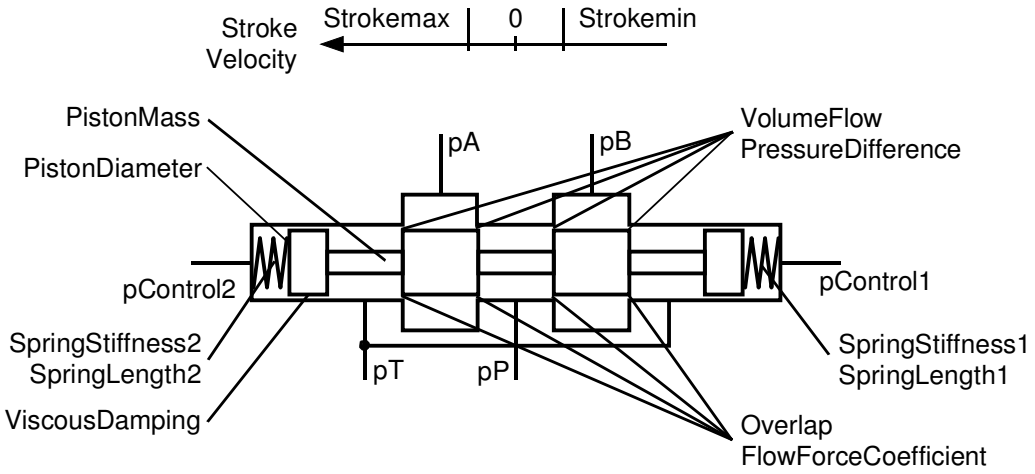
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43PT2).

ServoValve43Hydraulic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edges
Strokemax	1	Mm	maximum spool stroke for a positive stroke
Strokemin	-1	Mm	maximum spool stroke for a negative stroke
PistonDiameter	10	Mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	Mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2
SpringLength2	2	Mm	active length of spring 2
PistonMass	0.4	Kg	mass of the spool
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation

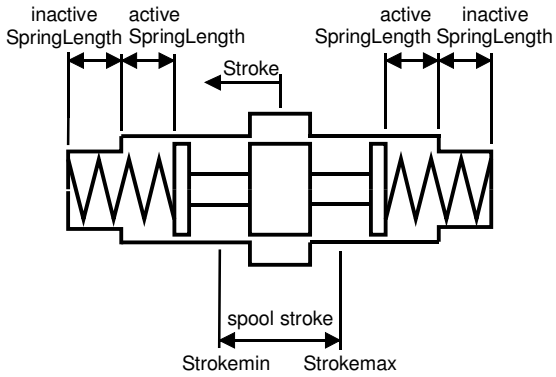
Notes

The component SERVOVALVE43HYDRAULIC is a model of a hydraulically controlled 3-way proportional valve. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:



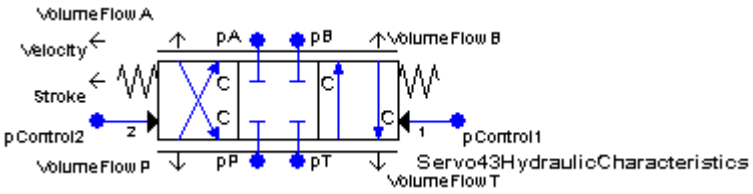
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

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In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO43HYDRAULICCHARACTERISTICS).

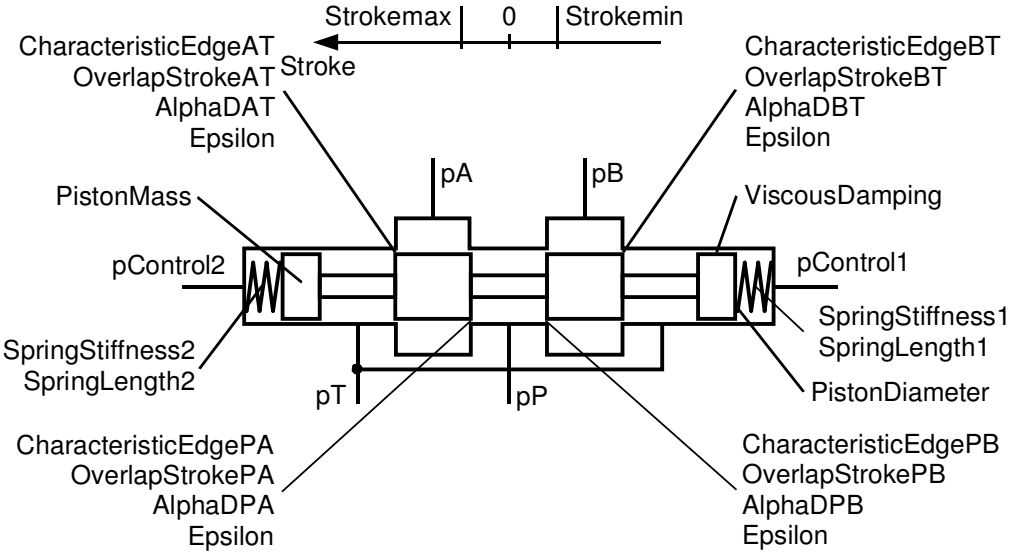
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Servo43HydraulicCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Epsilon	60	deg	flow angle
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDaemping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2

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Name	Value	Unit	Description
SpringLength2	2	mm	active length of spring 2
PistonMass	0.4	kg	mass of the spool
TDifference	0	K	Difference between local and system temperature

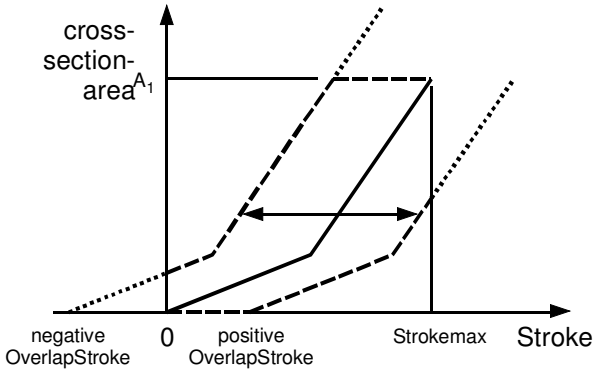
Notes

The component SERVO43HYDRAULICCHARACTERISTICS is a model of a hydraulically controlled 3-way proportional valve. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

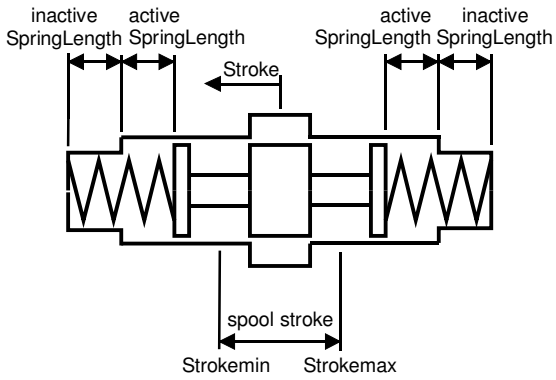
It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:



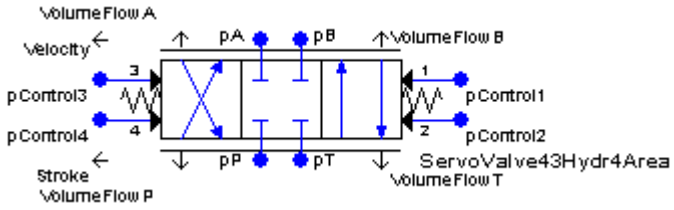
The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the

spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43HYDRAULIC).

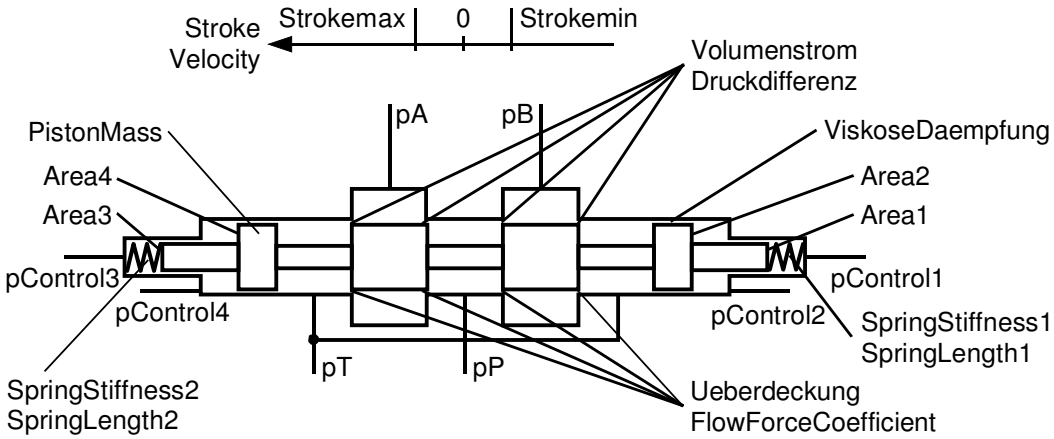
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ServoValve43Hydr4Area



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edges
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Area1	80	mm²	area pressurized with *pControl1*
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2
SpringLength2	2	mm	active length of spring 2
PistonMass	0.4	kg	mass of the spool
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation

Notes

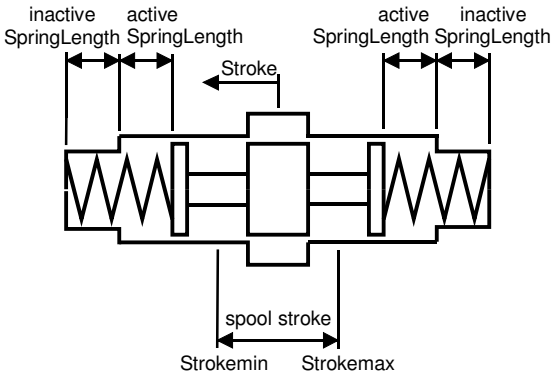
The component SERVOVALVE43HYDR4AREA is a model of a hydraulically controlled 3-way proportional valve with four pressure ports. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:

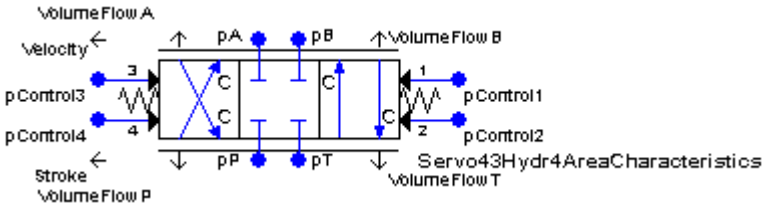
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The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

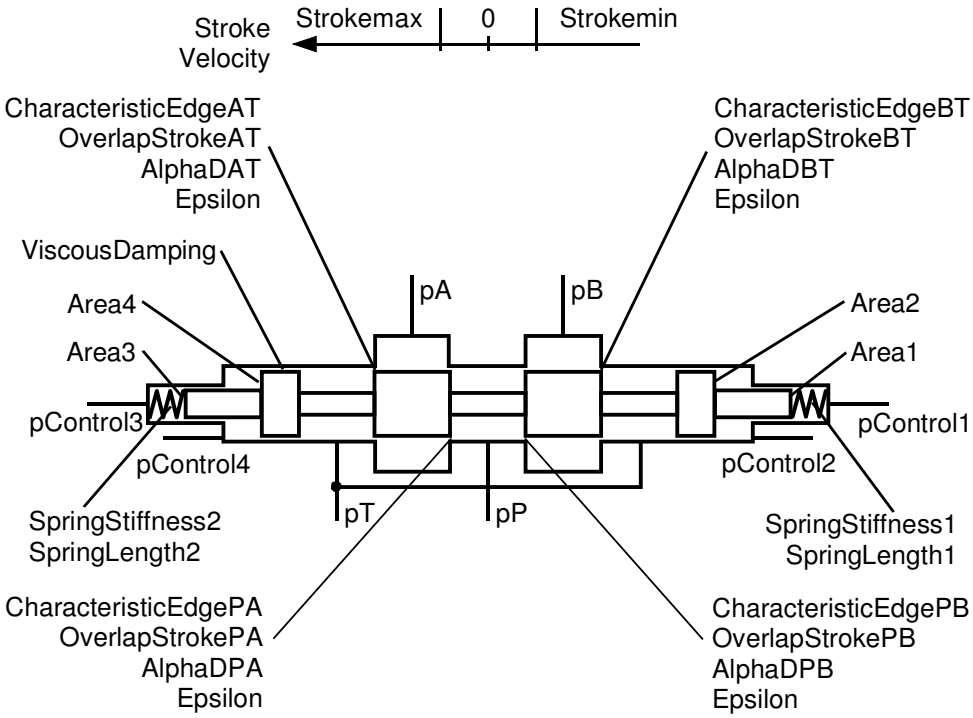
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO43HYDR4AREACHARACTERISTICS).

Servo43Hydr4AreaCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
pControl3	Hydr	bar	control pressure 3
pControl4	Hydr	bar	control pressure 4
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity

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Name	Type	Unit	Description
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Epsilon	60	deg	flow angle
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Area1	80	mm²	area pressurized with *pControl1*

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Name	Value	Unit	Description
Area2	80	mm²	area pressurized with *pControl2*
Area3	80	mm²	area pressurized with *pControl3*
Area4	80	mm²	area pressurized with *pControl4*
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2
SpringLength2	2	mm	active length of spring 2
PistonMass	0.4	kg	mass of the spool
TDifference	0	K	Difference between local and system temperature

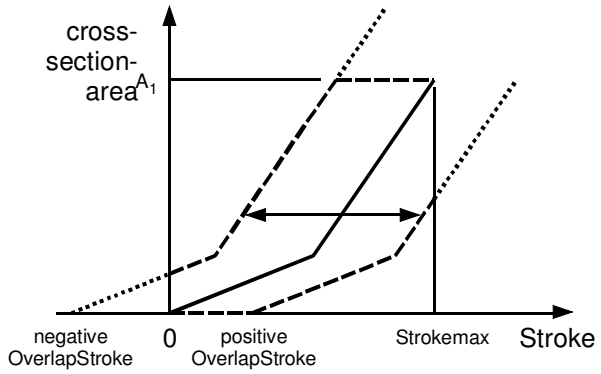
Notes

The component SERVO43HYDR4AREACHARACTERISTICS is a model of a hydraulically controlled 3-way proportional valve with four pressure ports. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

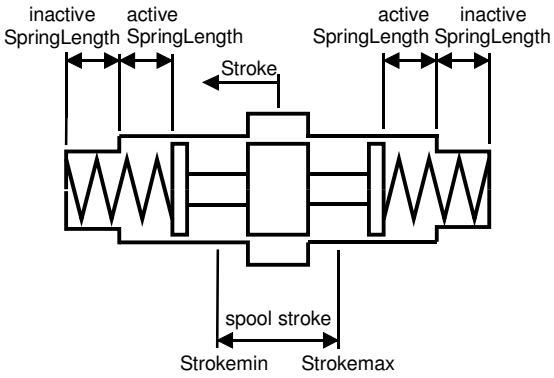
OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:

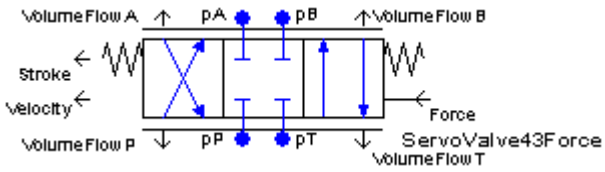
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The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

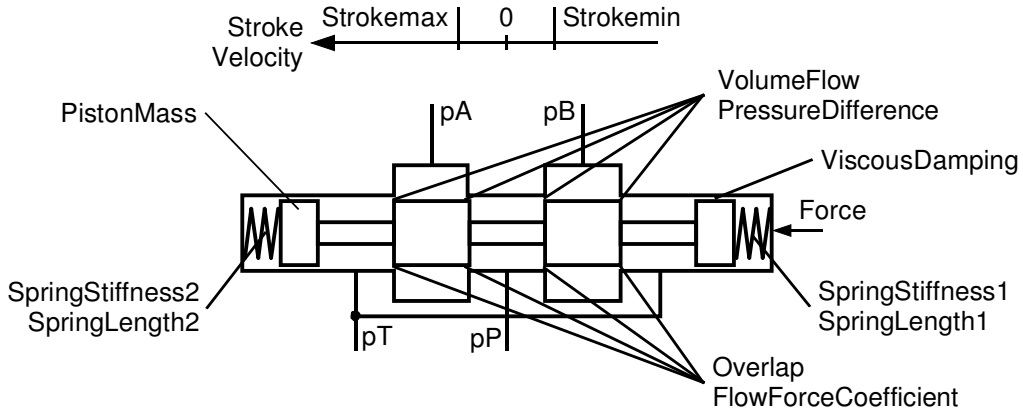
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43HYDR4AREA).

ServoValve43Force



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above

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Name	Value	Unit	Description
Overlap	0	%	relative overlap of the metering edges
ViscousDamping	10	N/mm	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2
SpringLength2	2	mm	active length of spring 2
PistonMass	0.4	kg	mass of the spool
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

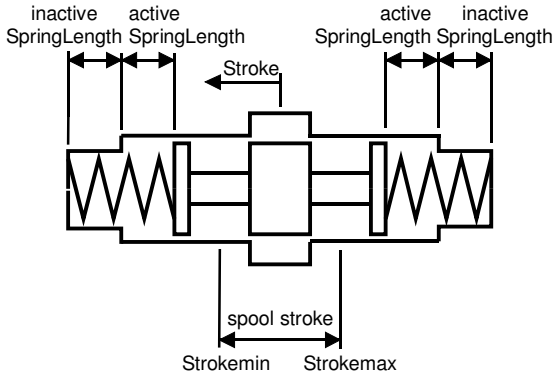
Notes

The component SERVOVALVE43FORCE is a model of a 3-way proportional valve which is controlled by *Force*. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

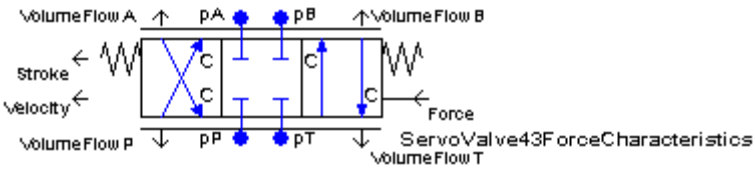
The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:



The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

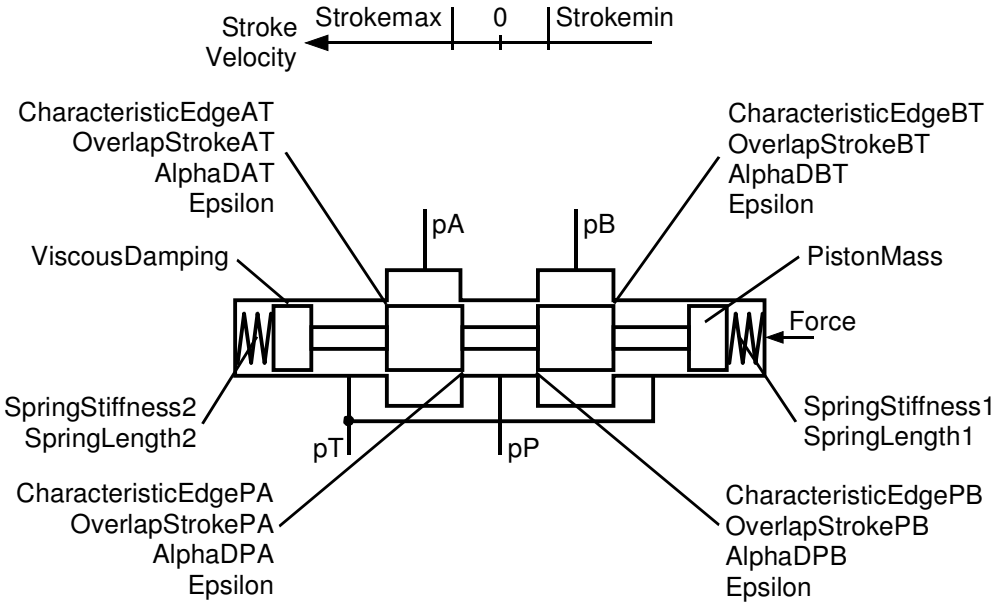
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVOVALVE43FORCECHARACTERISTICS).

ServoValve43ForceCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Epsilon	60	deg	flow angle
ViscousDamping	10	N/mm	velocity depending damping
SpringStiffness1	20	N/mm	stiffness of spring 1
SpringLength1	2	mm	active length of spring 1
SpringStiffness2	20	N/mm	stiffness of spring 2
SpringLength2	2	mm	active length of spring 2
PistonMass	0.4	kg	mass of the spool
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke

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Name	Value	Unit	Description
TDifference	0	K	Difference between local and system temperature

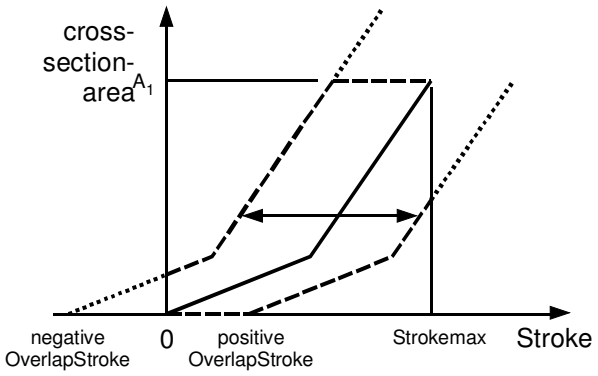
Notes

The component SERVOVALVE43FORCECHARACTERISTICS is a model of a 3-way proportional valve which is controlled by *Force*. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

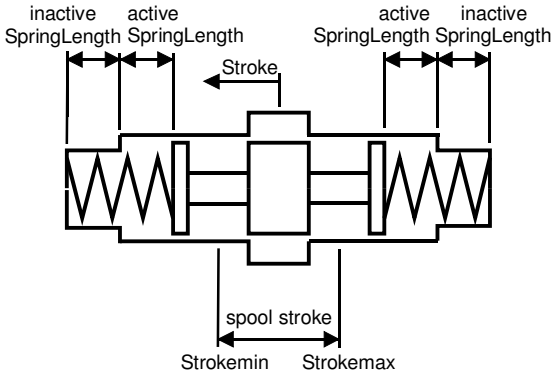
It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The parameters *SpringLength* represents the active length of a spring, that is the overall length minus the inactive length. The following figure shows the diagram of a valve in which the inactive lengths of the springs are also drawn in:

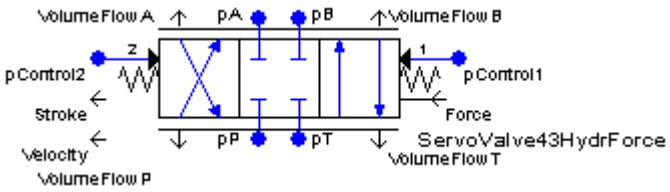


The overall length of the spring is measured in the non-artesian state. It is possible that the active spring length (*SpringLength1* or *SpringLength2*) is larger than the stroke of the spool (*Strokemax* - *Strokemin*). In this case the springs have a permanent pre-tension. Otherwise, the springs are not continually in contact with the piston.

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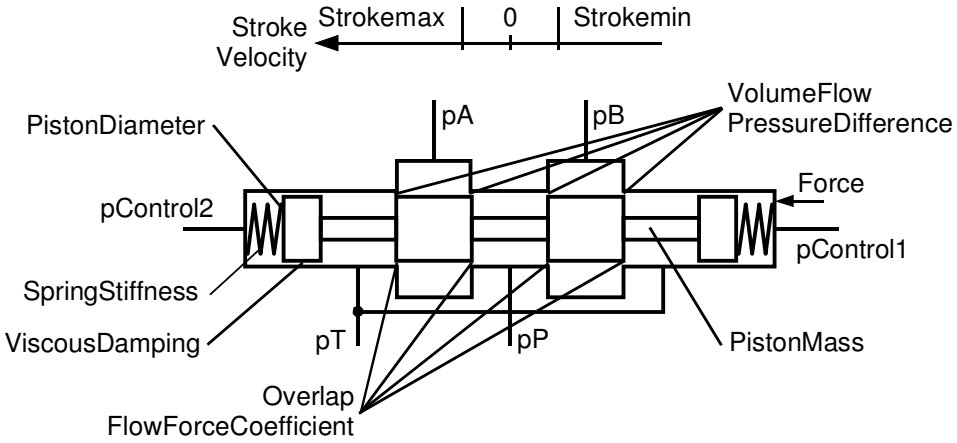
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43FORCE).

ServoValve43HydraulicForce



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through one metering edge at *PressureDifference*
PressureDifference	35	bar	see above
Overlap	0	%	relative overlap of the metering edges
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	100	N/mm	total stiffness of the springs
FlowForceCoefficient	0	N/mm/bar-	coefficient for the flow forces calculation
PistonMass	0.4	kg	mass of the spool

Notes

The component SERVOVALVE43HYDRAULICFORCE is a model of a hydraulically controlled 3-way proportional valve that has an additional *Force* input. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*.

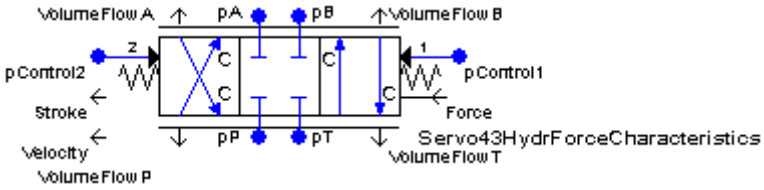
The overlap is the same for all metering edges and it applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The parameters *SpringLength* represents the total stiffness of the springs. In the resting position the sum of the spring forces is zero. In deflected position the spring is continually in contact.

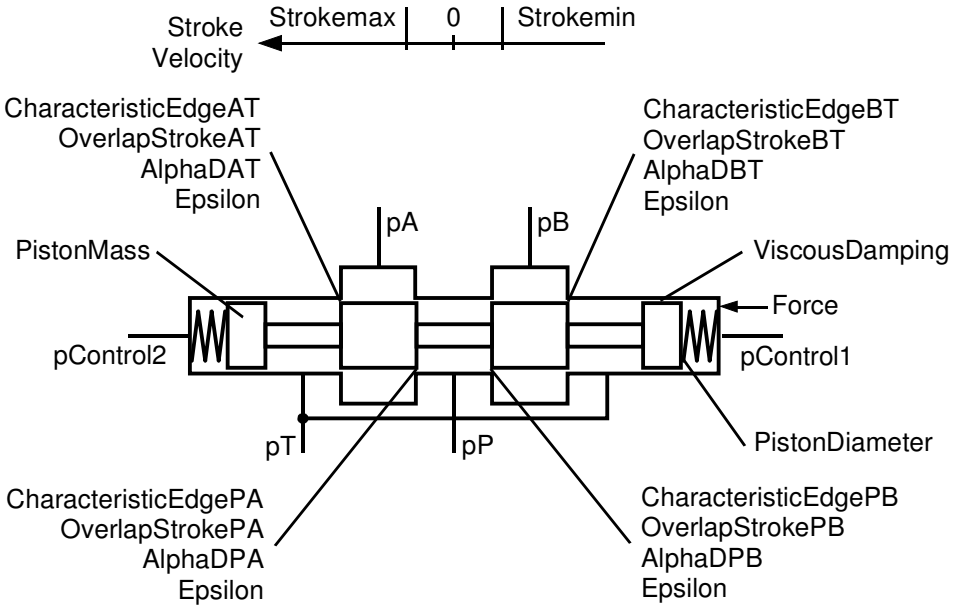
In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is parameterized with a look-up table (SERVO43HYDRFORCECHARACTERISTICS).

Servo43HydrForceCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pT	Hydr	bar	reservoir pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pControl1	Hydr	bar	control pressure 1
pControl2	Hydr	bar	control pressure 2
Force	In	N	force applying on the spool
Velocity	Out	m/s	spool velocity
Stroke	Out	mm	spool stroke
VolumeFlowP	Out	l/min	volume flow at connector P
VolumeFlowT	Out	l/min	volume flow at connector T
VolumeFlowA	Out	l/min	volume flow at connector A
VolumeFlowB	Out	l/min	volume flow at connector B

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Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	look-up table for the cross-section area of the metering edge from P to A
CharacteristicEdgeAT	-	-	look-up table for the cross-section area of the metering edge from A to T
CharacteristicEdgePB	-	-	look-up table for the cross-section area of the metering edge from P to B
CharacteristicEdgeBT	-	-	look-up table for the cross-section area of the metering edge from B to T
OverlapStrokePA	0	mm	complete overlap of the metering edge from P to A
OverlapStrokeAT	0	mm	complete overlap of the metering edge from A to T
OverlapStrokePB	0	mm	complete overlap of the metering edge from P to B
OverlapStrokeBT	0	mm	complete overlap of the metering edge from B to T
AlphaDPA	0.6	-	flow coefficient for the edge from P to A
AlphaDAT	0.6	-	flow coefficient for the edge from A to T
AlphaDPB	0.6	-	flow coefficient for the edge from P to B
AlphaDBT	0.6	-	flow coefficient for the edge from B to T
Strokemax	1	mm	maximum spool stroke for a positive stroke
Strokemin	-1	mm	maximum spool stroke for a negative stroke
Epsilon	60	deg	flow angle
PistonDiameter	10	mm	diameter of the areas pressurized with the control pressure
ViscousDamping	10	Ns/m	velocity depending damping
SpringStiffness	100	N/mm	stiffness of the spring
PistonMass	0.4	kg	mass of the spool
TDifference	0	K	Difference between local and system temperature

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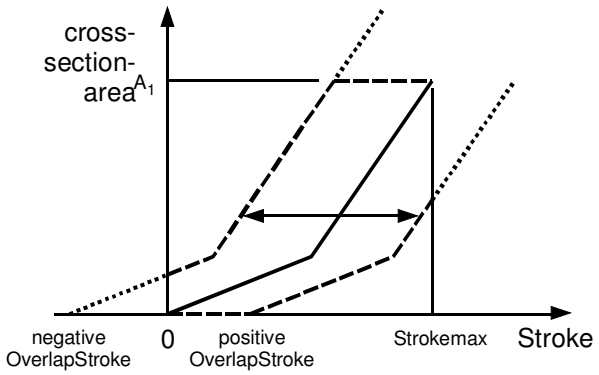
Notes

The component SERVOVALVE43HYDRAULICFORCECHARACTERISTICS is a model of a hydraulically controlled 3-way proportional valve that has an additional *Force* input. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the stroke.

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position



If the look-up table is defined in the range *Stroke* = *0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

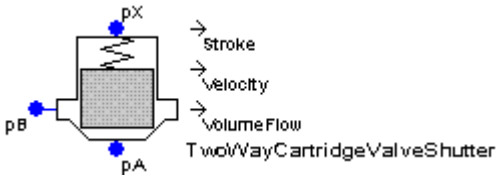
The parameters *SpringLength* represents the total stiffness of the springs. In the resting position the sum of the spring forces is zero. In deflected position the spring is continually in contact.

In addition, a model of this 3-way proportional valve is also available as a component, at which the flow characteristic is determined by the parameters *VolumeFlow* and *PressureDifference* (SERVOVALVE43HYDRAULICFORCE).

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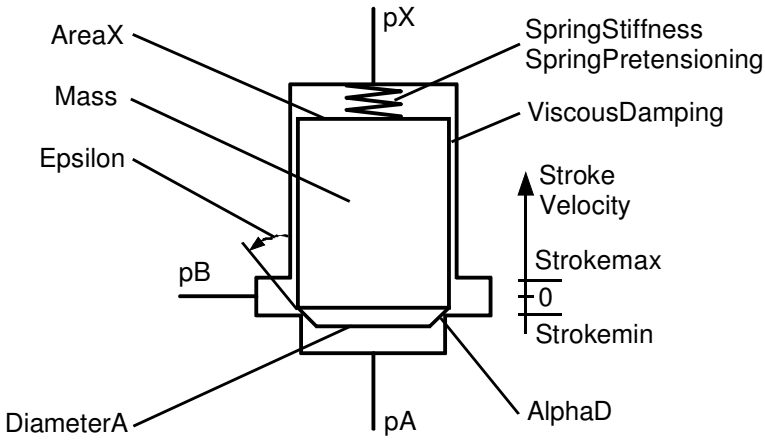
Additional valves

TwoWayCartridgeValveShutter



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	supply pressure
pB	Hydr	bar	working pressure
pX	Hydr	bar	control pressure
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
AlphaD	0.6	-	flow coefficient
Epsilon	30	deg	flow angle at the metering edge
Strokemax	4	mm	maximum spool stroke for a positive stroke
Strokemin	0	mm	maximum spool stroke for a negative stroke
SpringStiffness	10	N/mm	stiffness of the spring

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Name	Value	Unit	Description
SpringPretensioning	2	mm	pre-tension stroke of the spring
ViscousDamping	10	Ns/m	velocity depending damping
Mass	0.4	kg	mass of the piston
DiameterA	35	mm	diameter of area A
AaCloseAx	1	-	area ration area A / area X
TDifference	0	K	Difference between local and system temperature

Notes

The component TWOWAYCARTRIDGEVALVESHUTTER is a model of a 2-way cartridge valve that closes at raising control pressure *pX*.

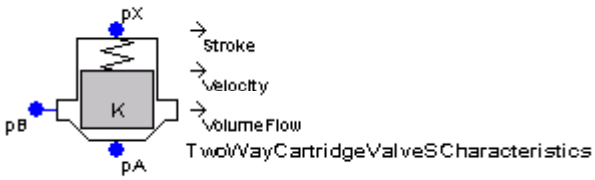
The flow coefficient *AlphaD* is in the range of *0,6* and *1,0*. For sharp metering edges the value is between *0,60* and *0,64*.

The parameters *Epsilon* determines the flow angle of the fluid passing the metering edge. It has a substantial influence on the flow forces:

$$F_{Str} \sim cos(Epsilon)$$

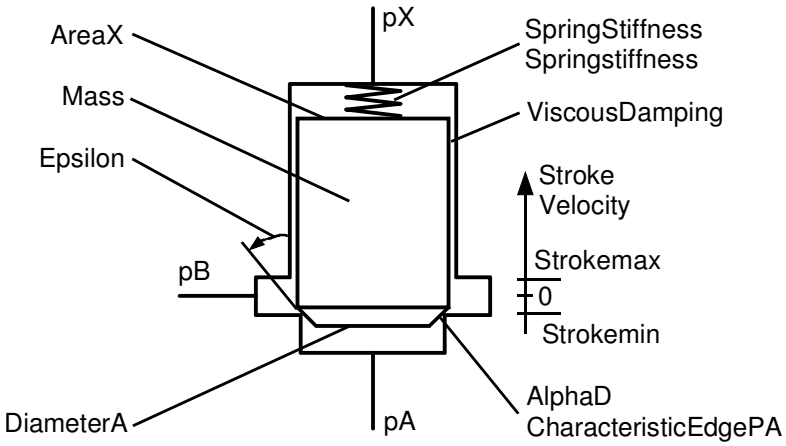
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TwoWayCartridgeValveSCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	supply pressure
pB	Hydr	bar	working pressure
pX	Hydr	bar	control pressure
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
AlphaD	0.6	-	flow coefficient
Epsilon	30	deg	flow angle at the metering edge
Strokemax	4	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	0	mm	maximum spool stroke for a negative stroke
SpringStiffness	10	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
ViscousDamping	10	Ns/m	velocity depending damping
Mass	0.4	kg	mass of the piston
DiameterA	35	mm	diameter of area A
AaCloseAx	1	-	area ration area A / area X
TDifference	0	K	Difference between local and system temperature

Notes

The component TWOWAYCARTRIDGEVALVESCHARACTERISTIC is a model of a 2-way cartridge valve that closes at raising control pressure *pX*.

The flow coefficient *AlphaD* is in the range of *0,6* and *1,0*. For sharp metering edges the value is between *0,60* and *0,64*.

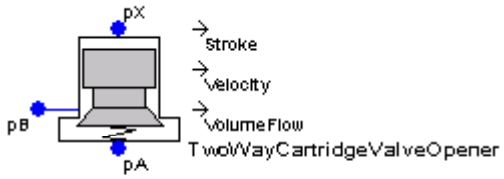
The parameters *Epsilon* determines the flow angle of the fluid passing the metering edge. It has a substantial influence on the flow forces:

$$F_{Str} \sim cos(Epsilon)$$

The flow characteristic of the valve is determined through a characteristic area, which describes the aperture cross section of the steering wheel edge in dependence to the stroke of the damper.
Receiving to the characteristic area the cross section is opened through a positive stroke.

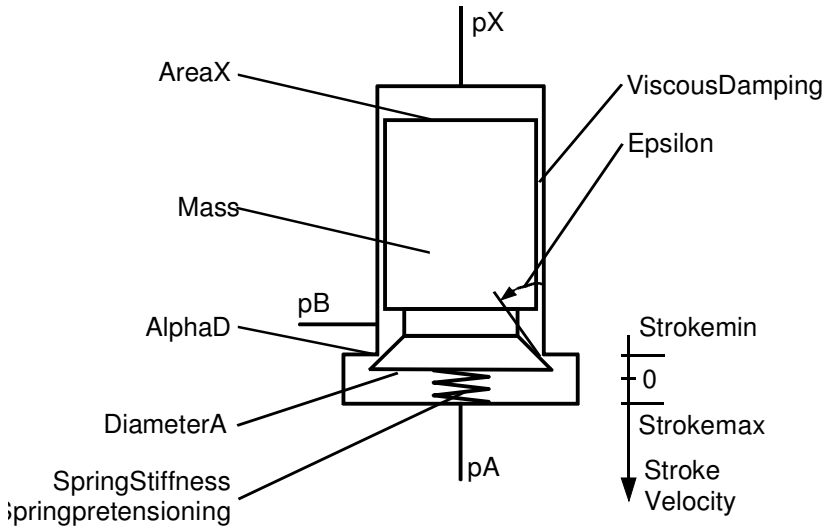
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TwoWayCartridgeValveOpener



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	supply pressure
pB	Hydr	bar	working pressure
pX	Hydr	bar	control pressure
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
AlphaD	0.6	-	flow coefficient
Epsilon	30	deg	flow angle at the metering edge
Strokemax	4	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	0	mm	maximum spool stroke for a negative stroke
SpringStiffness	10	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
ViscousDamping	10	Ns/m	velocity depending damping
Mass	0.4	kg	mass of the piston
DiameterA	35	mm	diameter of area A
AaCloseAx	1	-	area ration area A / area X
TDifference	0	K	Difference between local and system temperature

Notes

The component TWOWAYCARTRIDGEVALVEOPENER is a model of a 2-way cartridge valve that closes at raising control pressure *pX*.

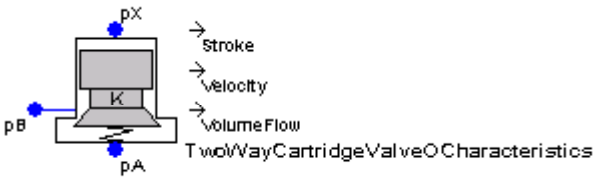
The flow coefficient *AlphaD* is in the range of *0,6* and *1,0*. For sharp metering edges the value is between *0,60* and *0,64*.

The parameters *Epsilon* determines the flow angle of the fluid passing the metering edge. It has a substantial influence on the flow forces:

$$F_{Str} \sim cos(Epsilon)$$

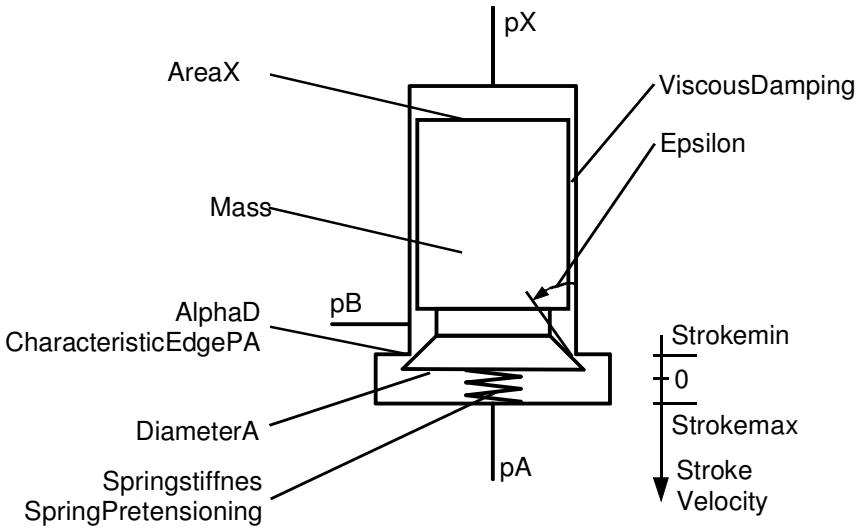
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TwoWayCartridgeValveOCharacteristics



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	supply pressure
pB	Hydr	bar	working pressure
pX	Hydr	bar	control pressure
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
AlphaDAB	0.6	-	flow coefficient
Epsilon	30	deg	flow angle at the metering edge
Strokemax	4	mm	maximum spool stroke for a positive stroke

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Name	Value	Unit	Description
Strokemin	0	mm	maximum spool stroke for a negative stroke
SpringStiffness	10	N/mm	stiffness of the spring
SpringPretensioning	2	mm	pre-tension stroke of the spring
ViscousDamping	10	Ns/m	velocity depending damping
Mass	0.4	kg	mass of the piston
DiameterA	35	mm	diameter of area A
AaToAx	1	-	area ration area A / area X
TDifference	0	K	Difference between local and system temperature

Notes

The component TWOWAYCARTRIDGEVALVEOCHARACTERISTIC is a model of a 2-way cartridge valve that closes at raising control pressure *pX*.

The flow coefficient *AlphaD* is in the range of *0,6* and *1,0*. For sharp metering edges the value is between *0,60* and *0,64*.

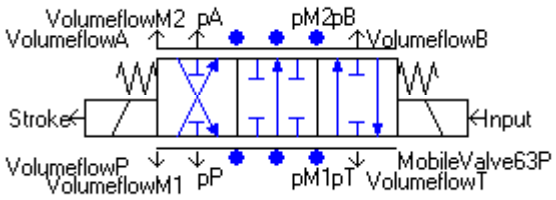
The parameters *Epsilon* determines the flow angle of the fluid passing the metering edge. It has a substantial influence on the flow forces:

$$F_{Str} \sim cos(Epsilon)$$

Receiving to the characteristic area the cross section is opened through a positive stroke.

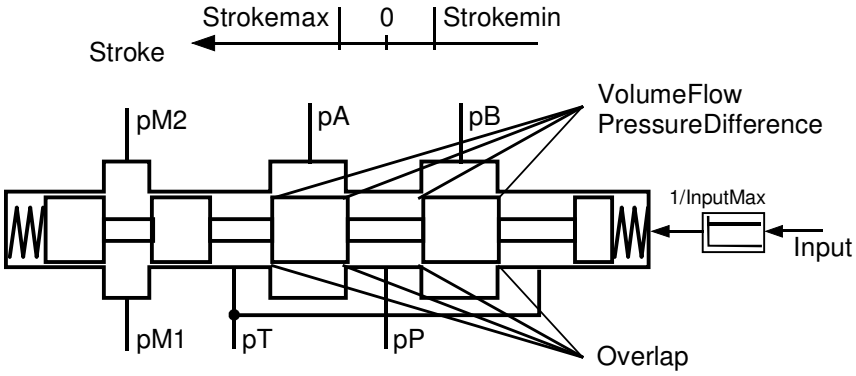
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MobileValve63P



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accomodation/providingpressure
pT	Hydr	bar	Tankpressure
pA	Hydr	bar	Workingpressure A
pB	Hydr	bar	Workingpressure B
pM1	Hydr	bar	z. B. Accomoda-tion/providingpressure
pM2	Hydr	bar	z. B. supply pipe to the next valve
Input	In	-	Inputsignal to the damperstroke
Stroke	V	mm	Stroke of the damper
VolumeFlowP	Out	l/min	VolumeFlow in Connector P
VolumeFlowT	Out	l/min	VolumeFlow in Connector T
VolumeFlowA	Out	l/min	VolumeFlow in Connector A
VolumeFlowB	Out	l/min	VolumeFlow in Connector B
VolumeFlowM1	Out	l/min	VolumeFlow in Connector M1
VolumeFlowM2	Out	l/min	VolumeFlow in Connector M2

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	VolumeFlow at maximum aperture cross section and adjacent *Pressuredifference*
Pressuredifference	35	bar	s.o.
Overlap	0	%	relative Overlap of the metering edges
VolumeFlowCenter	30	l/min	VolumeFlow through the valvemidposition at maximum Aperture cross section and adjacent *Pressuredifferencecenter*
PressuredifferenceCenter	5	bar	s.o.
OverlapCenter	0	%	relative Overlap of the centerposition
Strokemax	1	mm	maximum damperstroke in positive direction
Strokemin	-1	mm	maximum damperstroke in negative direction
InputMax	1	-	Standarization parameters to the inputsignal

Notes

The component MOBILEVALVE63P is the model of a 6/3-stroke-proportionalvalve, whichs damperstroke is proportional to the input. The flowcharacteristic of the workingconnectors of the valve is named by parameters *VolumeFlow*, *Pressuredifference* and *Overlap.* The centerposition flowcharacteristic of the valve is determined by parameters *VolumeFlow-Center, PressuredifferenceCenter* and *OverlapCenter*.

The overlap at the metering edges applies:

Overlap < *0*: metering edges in resting position opened
Overlap = *0*: metering edges in resting position just closed
Overlap > *0*: metering edges in resting position closed

The overlap at the centerposition applies:

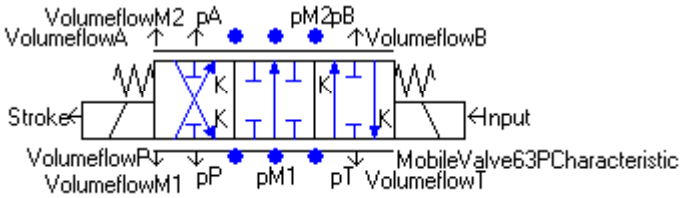
OverlapCenter < *0*: centerposition never closed completely
OverlapCenter = *0*: metering edges opened completely in resting position
OverlapCenter > *0*: centerposition will be closed before reaching the maximun valvestroke

The component MOBILEVALVE63P does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized

A model of a 6/3-stroke-proportionalvalve, whichs damperstroke is proportional to the input is even avaliable as a component whichs flowcharacteristics are named by characteristics (MOBILVENTIL63P-CHARACTERISTIC).

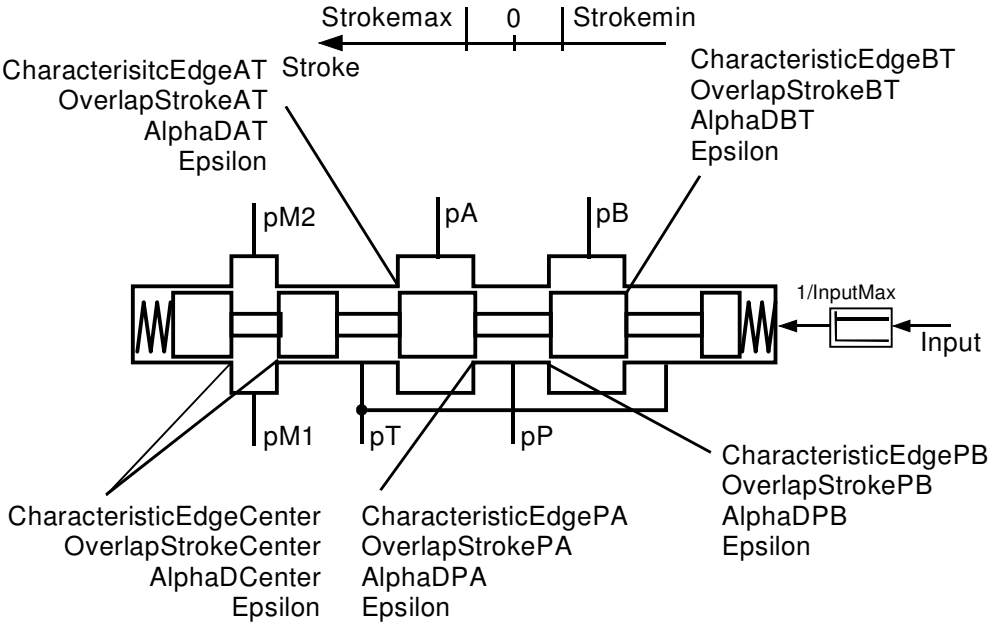
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MobileValve63PCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accomodation/providingpressure
pT	Hydr	bar	Tankpressure
pA	Hydr	bar	Workingpressure A
pB	Hydr	bar	Workingpressure B
pM1	Hydr	bar	z. B. Accomoda-tion/providingpressure
pM2	Hydr	bar	z. B. . supply pipe to the next valve
Input	In	-	Inputsignal to the damperstroke

Name	Type	Unit	Description
Stroke	V	mm	Stroke of the damper
VolumeFlowP	Out	l/min	VolumeFlow in Connector P
VolumeFlowT	Out	l/min	VolumeFlow in Connector T
VolumeFlowA	Out	l/min	VolumeFlow in Connector A
VolumeFlowB	Out	l/min	VolumeFlow in Connector B
VolumeFlowM1	Out	l/min	VolumeFlow in Connector M1
VolumeFlowM2	Out	l/min	VolumeFlow in Connector M2

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	Characteristic to the aperture cross section at the Metering edge from P to A
CharacteristicEdgeAT	-	-	Characteristic to the opening cross section at the Metering edge from A to T
CharacteristicEdgePB	-	-	Characteristic to the aperture cross section at the Metering edge from P to B
CharacteristicEdgeBT	-	-	Characteristic to the opening cross section at the Metering edge from B to T
CharacteristicEdgeCenter	-	-	Characteristic to the aperture cross section of the valvecenterposition
OverlapStrokePA	0	mm	Complete Overlap of the Metering edge from P to A
OverlapStrokeAT	0	mm	complete Overlap of the Metering edge from A to T
OverlapStrokePB	0	mm	complete Overlap of the Metering edge from P to B
OverlapStrokeBT	0	mm	complete Overlap of the Metering edge from B to T
OverlapStrokeCenter	0	mm	complete Overlap of the Metering edge in valvecenterposition
AlphaDPA	0.6	-	Flowcoefficient to the Edge from P to A
AlphaDAT	0.6	-	Flowcoefficient to the Edge from A to T

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Name	Value	Unit	Description
AlphaDPB	0.6	-	Flowcoefficient to the Edge from P to B
AlphaDBT	0.6	-	Flowcoefficient to the Edge from B to T
AlphaCenter	0.6	-	Flowcoefficient to the valvecenterposition
Strokemax	1	mm	maximum Damperstroke in positive Direction
Strokemin	-1	mm	maximum Damperstroke in negative Direction
InputMax	1	-	standardization parameters to the Inputsignal
TDifference	0	K	Difference between local and system temperature

Notes

The component MOBILVOVENTIL63PCHARACTERISTIC is the model of a 6/3-Stroke-proportionalvalve, whichs damperstroke is proportional to the input. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the *stroke.*

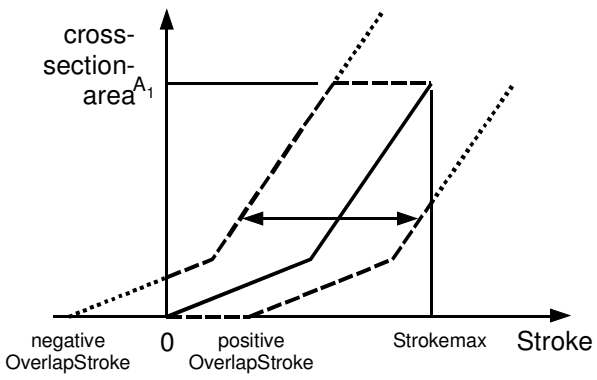
For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < *0*: metering edge opened in resting position
OverlapStroke = *0*: metering edge just closed in resting position
OverlapStroke > *0*: metering edge closed in resting position

The overlap at the centerposition applies:

OverlapCenteStroker < *0*: centerposition never closed completely
OverlapCenterStroke = *0*: metering edges in resting position openend completely
OverlapCenterStroke > *0*: centerposition will be closed before reaching the maximun valvestroke



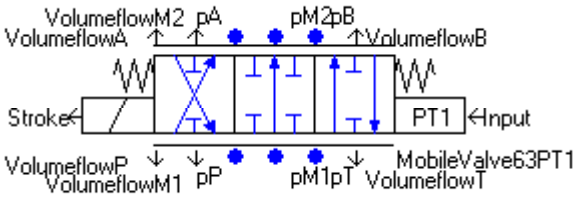
If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component MOBILVOVENTIL63PCHARACTERISTIC does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized

A model of a 6/3-stroke-proportionalvalve, whichs damperstroke is proportional to the input is even avaliable as a component whichs flowcharacteristics are named by parameters *VolumeFlow* and *PressureDifference* (MOBILVENTIL63P).

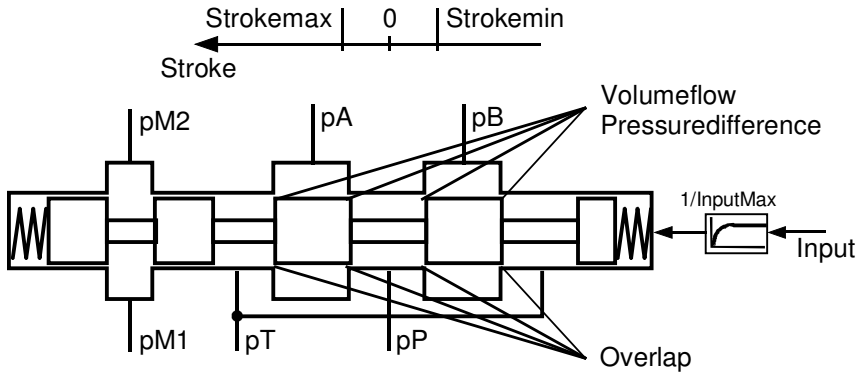
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MobileValve63PT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accomodation/providingpressure
pT	Hydr	bar	Tankpressure
pA	Hydr	bar	Workingpressure A
pB	Hydr	bar	Workingpressure B
pM1	Hydr	bar	z. B. Accomoda-tion/providingpressure
pM2	Hydr	bar	z. B. supply pipe to the next valve
Input	In	-	Inputsignal to the Damperstroke
Stroke	V	mm	Stroke of the Damper
VolumeFlowP	Out	l/min	VolumeFlow in Connector P
VolumeFlowT	Out	l/min	VolumeFlow in Connector T
VolumeFlowA	Out	l/min	VolumeFlow in Connector A
VolumeFlowB	Out	l/min	VolumeFlow in Connector B
VolumeFlowM1	Out	l/min	VolumeFlow in Connector M1
VolumeFlowM2	Out	l/min	VolumeFlow in Connector M2

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	VolumeFlow with maximum Aperture cross section and adjacent *Pressuredifference*
Pressuredifference	35	bar	s.o.
Overlap	0	%	relative Overlap of the Metering edges
VolumeFlowCenter	30	l/min	VolumeFlow through the valve-centerposition with maximum Aperture cross section and adjacent *PressuredifferenceCenter*
PressuredifferenceCenter	5	bar	s.o.
OverlapCenter	0	%	relative Overlap of the Centerlposition
Strokemax	1	mm	maximum Damperstroke in positive Direction
Strokemin	-1	mm	maximum Damperstroke in negative Direction
InputMax	1	-	Standarization parameters to the Inputsignal
TimeConstance	10	ms	parameters for control characteristics

Notes

The component MOBILVENTIL63PT1 is a model of a 6/3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over the parameters *VolumeFlow, PressureDifference* and *Overlap*. The centerposition flowcharacteristic of the valve is determined by parameters *VolumeFlow-Center, PressureDifferenceCenter* and *OverlapCenter*.

The overlap at the metering edges applies:

Overlap < *0*: metering edges opened in resting position
Overlap = *0*: metering edges just closed in resting position
Overlap > *0*: metering edges closed in resting position

The overlap at the centerposition applies:

OverlapCenter < 0*:* centerposition never completely closed
OverlapCenter = 0*:* metering edges in resting position completely opened

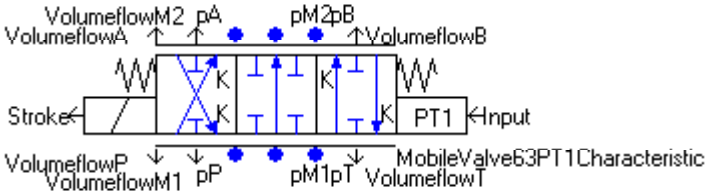
OverlapCenter > *0*: *centerposition* centerposition will be closed before reaching the maximun valvestroke

The component CONTROLVALVE43PT1 does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized, because the *Stroke* of the valve damper only depends on the signal at the *Input* and on *TimeConstance*.

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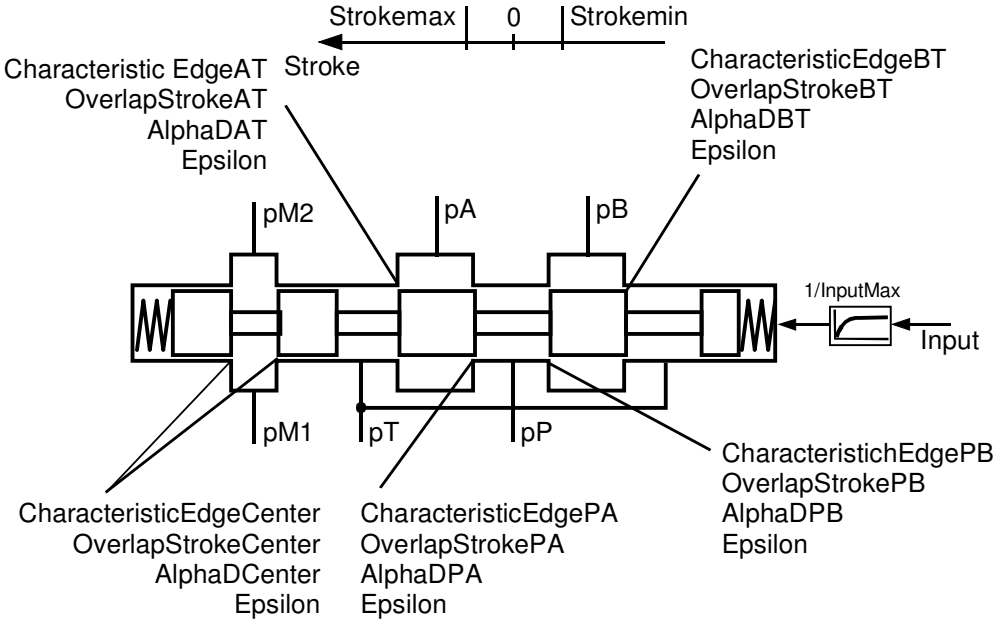
A model of a 6/3-stroke-proportionalvalve, whichs damperstroke is proportional to the inputsignal according to a first order delay is even avaliable as a component whichs flow-characteristics are named by characteristics (MOBILVENTIL63PT1CHARACTERISTIC).

MobileValve63PT1Characteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accomodation/providingpressure
pT	Hydr	bar	Tankpressure
pA	Hydr	bar	Workingpressure A
pB	Hydr	bar	Workingpressure B
pM1	Hydr	bar	z. B. Accomoda-tion/providingpressure
pM2	Hydr	bar	z. B. supply pipe to the next valve
Input	In	-	Inputsignal to the Damperstroke
Stroke	V	mm	Stroke of the Damper

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Name	Type	Unit	Description
VolumeFlowP	Out	l/min	VolumeFlow in Connector P
VolumeFlowT	Out	l/min	VolumeFlow in Connector T
VolumeFlowA	Out	l/min	VolumeFlow in Connector A
VolumeFlowB	Out	l/min	VolumeFlow in Connector B
VolumeFlowM1	Out	l/min	VolumeFlow in Connector M1
VolumeFlowM2	Out	l/min	VolumeFlow in Connector M2

Parameters

Name	Value	Unit	Description
CharacteristicEdgePA	-	-	Characteristic for the aperture cross section at the metering edge from P to A
CharacteristicEdgeAT	-	-	Characteristic for the aperture cross section at the metering edge from A to T
CharacteristicEdgePB	-	-	Characteristic for the aperture cross section at the metering edge from P to B
CharacteristicEdgeBT	-	-	Characteristic for the aperture cross section at the metering edge from B to T
CharacteristicEdgeCenter	-	-	Characteristic for the aperture cross section at the valvecenterposition
OverlapStrokePA	0	mm	complete Overlap of the Metering edge from P to A
OverlapStrokeAT	0	mm	complete Overlap of the Metering edge from A to T
OverlapStrokePB	0	mm	complete Overlap of the Metering edge from P to B
OverlapStrokeBT	0	mm	complete Overlap of the Metering edge from B to T
OverlapStrokeCenter	0	mm	complete Overlap of the Metering edge at the valvecenterposition
AlphaDPA	0.6	-	Flowcoefficient for the Edge from P to A
AlphaDAT	0.6	-	Flowcoefficient for the Edge from A to T
AlphaDPB	0.6	-	Flowcoefficient for the Edge from P to B

Name	Value	Unit	Description
AlphaDBT	0.6	-	Flowcoefficient for the Edge from B to T
AlphaCenter	0.6	-	Flowcoefficient for the Edge at valvecenterposition
Strokemax	1	mm	maximum Damperstroke in positive Direction
Strokemin	-1	mm	maximum Damperstroke in negative Direction
InputMax	1	-	Standarization parameters to the Inputsignal
TimeConstance	10	ms	parameters for control characteristics
TDifference	0	K	Difference between local and system temperature

Notes

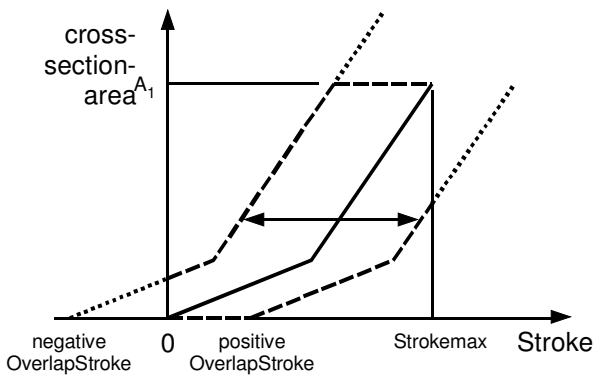
The component MOBILEVALVE63PT1CHARACTERISTIC is a model of a 6/3-way proportional valve at which the stroke follows the input signal according to a first order delay. The flow characteristic is parameterized over a look-up table that defines the cross-section area in dependence of the *Stroke.*

For the look-up table, it is assumed that a positive *Stroke* opens the metering edge. The look-up table is displaced with the *OverlapStroke* of the metering edge to different starting points (see figure).

It applies:

OverlapStroke < 0: metering edge opened in resting position
OverlapStroke = 0: metering edge just closed in resting position
OverlapStroke > 0: metering edge closed in resting position
The overlap at the centerposition applies:

OverlapCenteStroker < 0: centerposition never closed completely
OverlapCenterStroke = 0: metering edges in resting position opened completely
OverlapCenterStroke > 0: centerposition will be closed before reaching the maximun valvestroke



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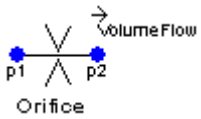
If the look-up table is defined in the range *Stroke = 0..Strokemax* the cross-section area does not exceed A_1 in case of a negative overlap. If the look-up table is defined beyond *Strokemax* the cross-section area follows the look-up table.

The component MOBILEVALVE63PT1CHARACTERISTIC does not represent a physical model of the valve but only its characteristic properties. Therefore the physical properties (e. g. mass of the spool, stiffness of the spring) are not parameterized, because the *Stroke* of the valve damper only depends on the signal at the *Input* and on *TimeConstance*.

A model of a 6/3-stroke-proportionalvalve, whichs damperstroke is proportional to the inputsignal according to a first order delay is even avaliable as a component whichs flow-characteristics are named by parameters *VolumeFlow* and *Pressuredifference* (MOBIL-VENTIL63PT1).

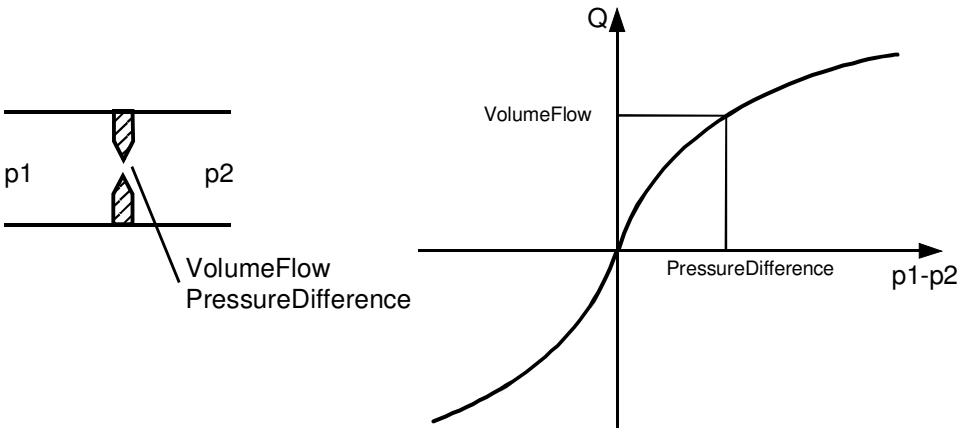
Resistors

Orifice



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out	l/min	flow through the orifice (*Q*)

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the orifice at *PressureDifference*
PressureDifference	5	bar	see above

Notes

The component ORIFICE is a model of a fluid resistance with to a large extent root shaped dependence of the *VolumeFlow* on the *PressureDifference p1-p2* connected to the component. It is parameterized over the parameters *VolumeFlow* and *PressureDifference*.

$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

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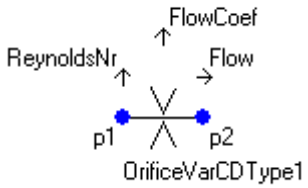
The ORIFICE is suitable for modeling an orifice opening, if the ratio of its length l to its diameter d is comparatively small. (approx. $l/d < 1{,}5$)

The *VolumeFlow* is independent from the viscosity of the hydraulic liquid.

In addition to the ORIFICE exists the component NOZZLE with identical, root shaped characteristic that however is determined via its geometric parameters diameter and AlphaD.

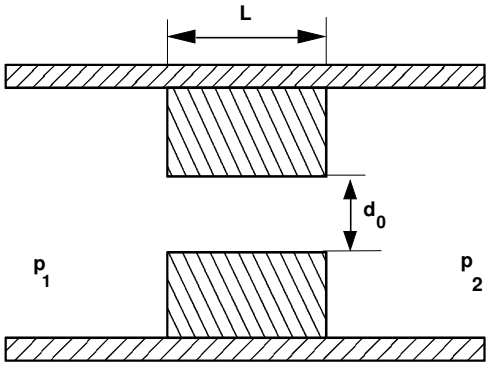
A model of an orifice is also available as a component with that the ratio of *VolumeFlow* to *PressureDifference p1-p2* is adjustable by means of an input signal (VARIABLEORIFCE).

OrificeVarCDType1



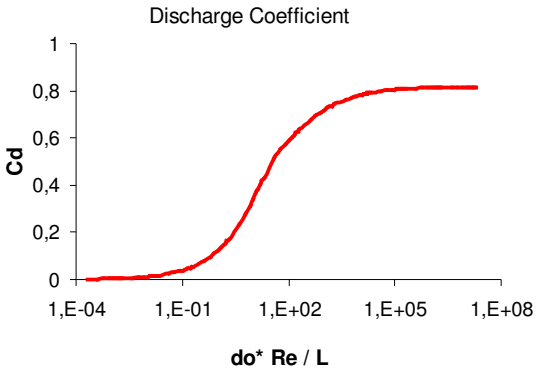
Symbol

Sketch



L — Length of the orifice

d_0 — diameter of orifice



Connections and variables

Name	Type	Unit	Description
p1	Hydr	bar	Pressure at side 1
p2	Hydr	bar	Pressure at side 2
Flow	Out	l/min	Flow through the orifice
ReynoldsNr	Out	-	Calculated Reynolds number
FlowCoef	Out	-	Calculated Discharge Coefficient

Parameter

Name	Value/Unit		Description
Diameter	5.0	mm	Diameter of the Orifice
Length	2.5	mm	Length of the Orifice
TDifference	0	K	Difference between local and system Temperature

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Notes

The Component ORIFICEVARCDTYPE1 is a model of an Orifice, which is relatively extended and possess a cylindrical bore. The length and diameter of orifice is given and the necessary flow, Reynolds number and the flow coefficient is computed. The ratio of Length and Diameter is larger and is parameterized over the parameters *Length, Diameter* and *AlphaD*.

The Component ORIFICEFLOWCOEF is modeled for calculating the *FlowCoef* depending on the Length and Diameter of the Orifice and the Reynolds number.

The Flow is calculated using a constant FlowCoef (*AlphaD*) at the beginning

$$Q = A * C_D * \sqrt{\frac{2}{\rho}} \sqrt{(p1 - p2)}$$

With: Q = Flow through the Orifice

$A = \frac{\pi d_o^{\,2}}{4}$ Surface Area of the Orifice

C_D = Flow Coefficient (*AlphaD*)

ρ = Density

$p1 - p2$ = Pressure Difference

The Reynolds Number is determined with the *Flow* obtained by the above equation

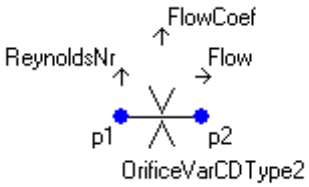
$$Re = \frac{4Q}{\pi d_o \nu}$$

with: ν Kinematic Viscosity

The Flow Coefficient is now calculated by

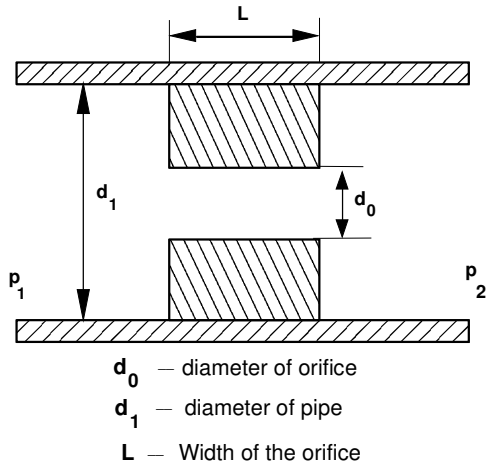
$$Cd = \begin{cases} \left[2.164 + 64\frac{l}{d0\,\mathrm{Re}}\right]^{-0.5} & \text{For } \frac{do\,\mathrm{Re}}{l} \langle = 50 \\ \left[1.5 + 13.74\left(\frac{l}{d0\,\mathrm{Re}}\right)^{0.5}\right]^{-0.5} & \text{For } \frac{do\,\mathrm{Re}}{l} \rangle 50 \end{cases}$$

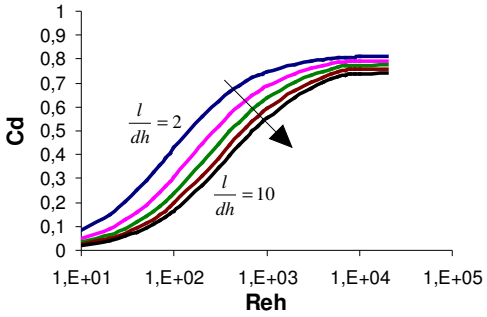
OrificeVarCDType2



Symbol

Sketch





Connections and variables

Name	Type	Unit	Description
p1	Hydr	bar	Pressure at side 1
p2	Hydr	bar	Pressure at side 2
Flow	Out	l/min	Flow through the Orifice (Q)
ReynoldsNr	Out	-	Reynolds number value
FlowCoef	Out	-	Discharge Coefficent (Cd) obtained by the Flow through orifice and the Reynolds number

Parameter

Name	Value/Unit		Description
HydDiameter	2.5	mm	Hydraulic Diameter d_h
BETA	0.5	-	Diameter ratio β: d_0/d_1 for circular section d_h/d_1 for non circular section
Length	5.0	mm	Length L of the Orifice

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Name	Value/Unit		Description
TDifference	0	K	Difference between local and system Temperature

Notes

The Component OrificeHydLD is a model of an Orifice, which is relatively extended and possess a cylindrical bore. The length and diameter of orifice, diameter of the tube and the hydraulic diameter is given and the necessary flow, Reynolds number and the flow coefficient is computed. The ratio of Length and Diameter is parameterized over the parameters *Length, DiameterPipe* and *HydDiameter.*

The parameter *HydDiameter* is defined by

$$d_h = \frac{4A}{S}$$

with : A - flow section area and S - the flow section perimeter.

Hydraulic Diameter dh is used for non circular sections. $dh = d0$ for circular sections.

$d0$ is the diameter of the orifice

The Flow coefficient is calculated for Reynolds number in between 10 & 20000 and the ratio of *Length* to *HydDiameter* in between 2 & 10.

For : $2 \langle \frac{l}{dh} \langle 10$ and $10 \langle \mathrm{Re}\,h \langle 20000$;

$$\frac{1}{Cd} = \sqrt{1-\beta^4}\left[\frac{1}{Cd\max} + \frac{20}{\mathrm{Re}\,h}\left(1+2.25\frac{l}{dh}\right) - \frac{0.005\frac{l}{dh}}{1+7.5(\log \mathrm{Re}\,h - 3.824)^2}\right]$$

with: $\mathrm{Re}\,h = \sqrt{\frac{2\Delta p}{\rho}}\frac{dh}{\nu}$

$$Cd\max = 0.827 - 0.0085\frac{l}{d_h}$$

$\beta = \frac{d_0}{d_1}$ (Circular Section with $d1$ as the diameter at the high pressure side)

$\beta = \frac{d_h}{d_1}$ (Non Circular Section)

The *Flow* is determined from the obtained Cd value

$Q = A * C_D * \sqrt{\frac{2}{\rho}}\ \sqrt{(p1 - p2)}$

With: Q Flow through the Orifice

A = $\frac{\pi d0^2}{4}$ Surface Area of the Orifice

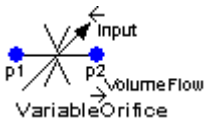
C_D Flow Coefficient

ρ Density

$p1 - p2$ Pressure Difference

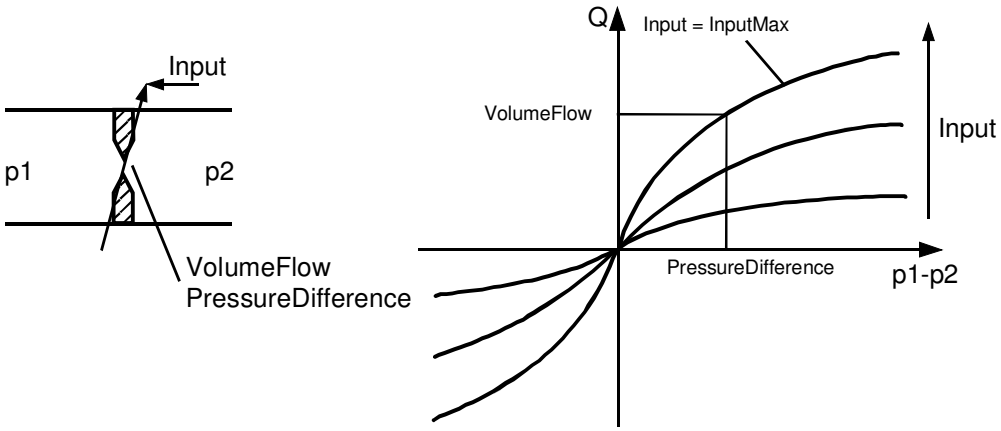
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VariableOrifice



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
Input	In	-	input signal to adjust the orifice
VolumeFlow	Out	l/min	flow through the orifice

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the orifice at *PressureDifference* and *InputMax*
PressureDifference	5	bar	see above
InputMax	1	-	maximum input signal

Notes

The component VARIABLEORIFICE is a model of a variable fluid resistance with to a large extent root shaped dependence of the *VolumeFlow* on the *PressureDifference p1-p2* connected to the component. The relation between the *VolumeFlow* and the *PressureDifference p1-p2* is adjustable via the input signal.

$$Q = \alpha_b A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

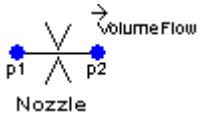
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The VARIABLEORIFICE is suitable for modeling an orifice opening, if the ratio of its length l to its diameter d is comparatively small. (approx. $l/d < 1{,}5$).

The *VolumeFlow* is independent from the viscosity of the hydraulic liquid.

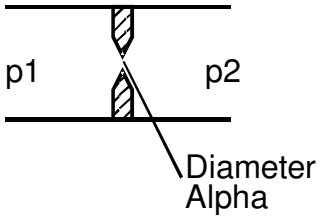
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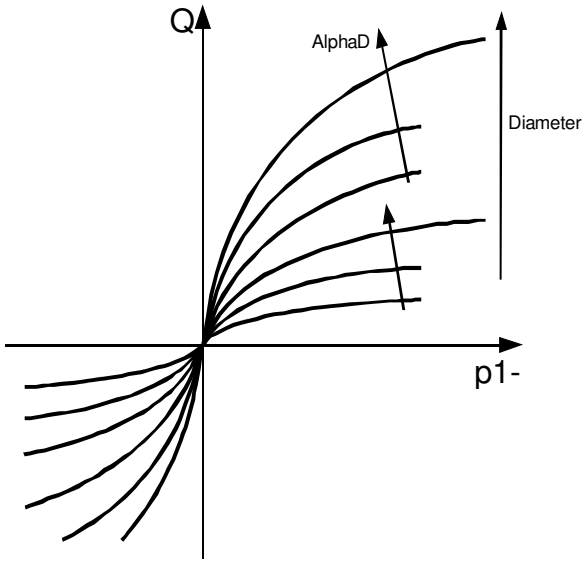
Nozzle



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out	l/min	flow through the component

Parameters

Name	Value	Unit	Description
Diameter	1	mm	diameter of the hole
AlphaD	0.6	-	flow coefficient
TDifference	0	K	Difference between local and system temperature

Notes

The component NOZZLE is a model of a fluid resistance with to a large extent root shaped dependence of the *VolumeFlow* on the *PressureDifference p1-p2* connected to the component. It is parameterized over the geometric parameters *diameter* and *AlphaD*. The density of the hydraulics liquid (*Rho*) is considered.

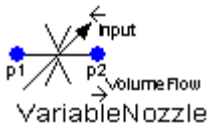
$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

In addition to the NOZZLE, the component ORIFICE exists with the same, root shaped characteristic, which however is parameterized over the hydraulic ratings *VolumeFlow* and *PressureDifference*.

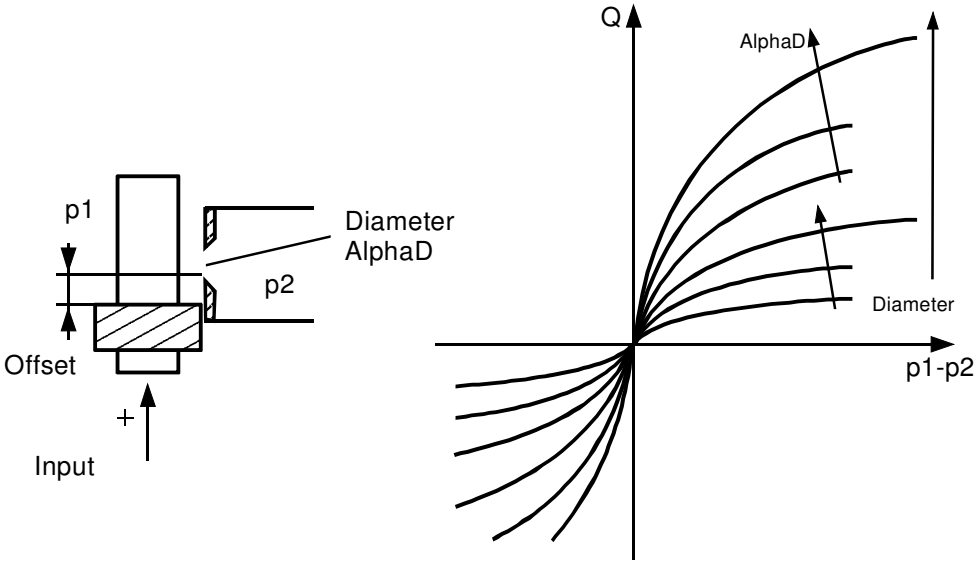
 © 2008 FLUIDON GmbH

VariableNozzle



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out	l/min	flow through the component
Input	IN	-	Input signal

Parameters

Name	Value	Unit	Description
Diameter	1	mm	Diameter of the Nozzle
TDifference	0	K	difference between local and system temperature
AlphaD	0.6	-	Flow coefficient
Quantity	1	-	Number of used VARIABLENOZZLE
Offset	0	mm	Starting point overlap
Sign	1		Algebraic sign of the overlap

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Notes

The component VARIABLENOZZLE is a model of a circularly fluid resistance with to a large extent root shaped dependence of the volume flow on the pressure difference *p1-p2* connected to the component. It is parameterized over the geometric parameters *diameter* and *AlphaD*. The density of the hydraulics liquid (*Rho*) is adjusted in the fluid options.

$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

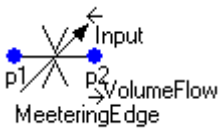
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The *Input* signal defines the actual opening level of the VARIABLENOZZLE. The achtual cross section area is calculated during the simulation. The paramter Offset characterizes the starting point.

In addition to the VARIABLENOZZLE, the component VARIABLEORIFICE exists with the same, root shaped characteristic, which however is parameterized over the hydraulic ratings *VolumeFlow* and *PressureDifference*.

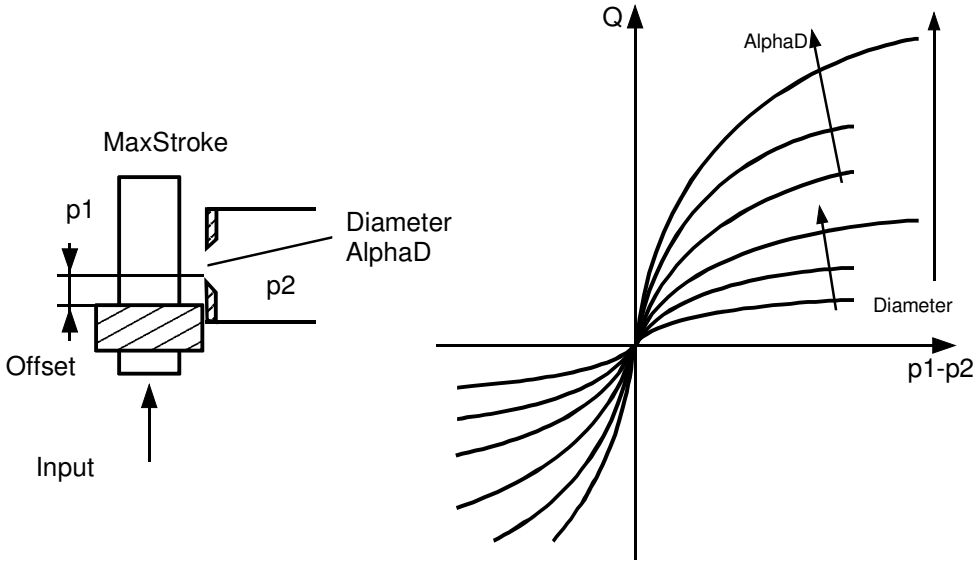
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MeeteringEdge



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	Inlet pressure
p2	Hydr	bar	Outlet pressure
Input	In	mm	Input signal
VolumeFlow	Out	l/min	Volume flow through the meetering edge

Parameters

Name	Value	Unit	Description
Diameter	8	mm	Diameter of the meetering edge
AlphaD	0.6	-	Flow coefficient
MaxStroke	4	mm	Maximum valve stroke
Offset	0	mm	Stroke offset
Sign	1	-	Algebraic sign of the stroke offset

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Name	Value	Unit	Description
Tdifference	0	K	Difference between local and system temperature

Notes

The component MEETERINGEDGE is a model of a circularly fluid resistance with to a large extent root shaped dependence of the volume flow on the pressure difference *p1-p2* connected to the component. It is parameterized over the geometric parameters *Diameter* and *MaxStroke* and the flow coefficient *AlphaD*. The density of the hydraulics liquid (*Rho*) is adjusted in the fluid options.

$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

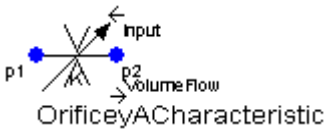
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The *Input* signal defines the actual opening level of the MEETERINGEDGE. The achtual cross section area is calculated during the simulation. The paramter Offset characterizes the starting point.

In addition to the MEETERINGEDGE, the component VARIABLEORIFICE exists with the same, root shaped characteristic, which however is parameterized over the hydraulic ratings *VolumeFlow* and *PressureDifference*.

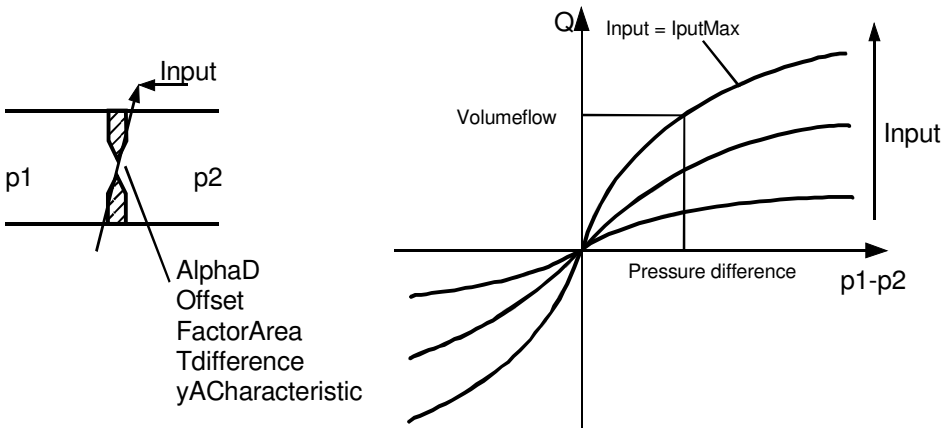
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OrificeyACharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the component
Input	In	-	Input signal

Parameters

Name	Value	Unit	Description
AlphaD	0.7	-	Flow coefficient
Offset	0	-	Input offset
FactorArea	1	-	Proportional factor
Tdifference	0	K	Temperature difference between Inlet and outlet
yACharacteristic	-1	-	Characteristic field

Notes

The component OrificeyACharacteristic is a model of a tunable flow resistance with to a large extent root shaped dependence of the *VolumeFlow* and the pressure difference.

$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} \sqrt{(p_1 - p_2)}$$

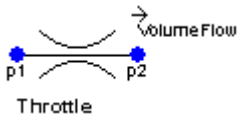
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(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

However it is parameterized with the characteristic values for *AlphaD, Tdifference*, *FactorArea, Offset* and with the look-up table *yACharacteristic* for the cross section area. With the paramter *FactorArea* the look-up table values can be extended or compressed.

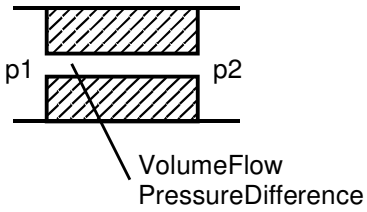
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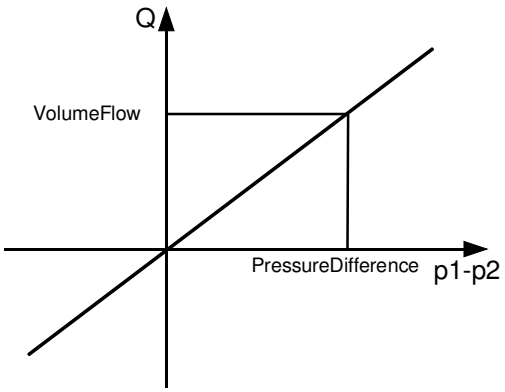
Throttle



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the throttle

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the throttle at *PressureDifference*
PressureDifference	5	Bar	see above

Notes

The component THROTTLE is a model of a fluid resistance with to a large extent linear shaped dependence of the *VolumeFlow* on the *PressureDifference p1-p2* connected to the component. It is parameterized over the hydraulic parameters *VolumeFlow* and *PressureDifference*.

$$Q = \frac{\pi r^4}{8\eta l}(p_1 - p_2)$$

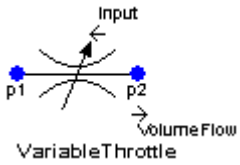
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The THROTTLE is also available as a component whereas the relation between the *VolumeFlow* and the *PressureDifference p1-p2* is adjustable via an input signal. (VARIABLETHROTTLE)

In addition to the THROTTLE, the component BORE exists with the same, linear shaped characteristic, which however is parameterized over the geometric parameters *Diameter* and *Length*.

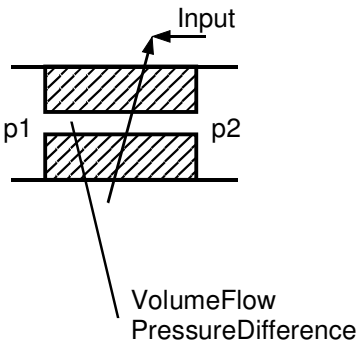
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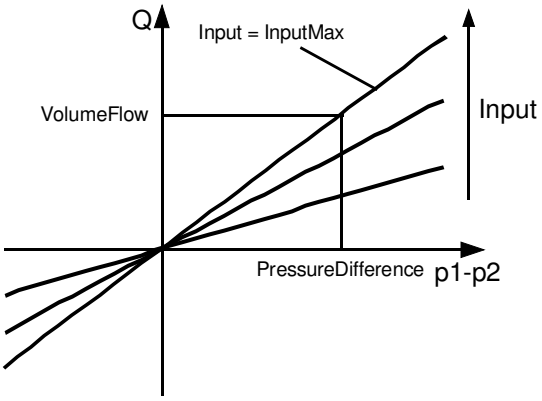
VariableThrottle



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	Bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
Input	In	-	inputs signal to adjust the throttle
VolumeFlow	Out		volume flow at the throttle (*Q*)

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the throttle at *PressureDifference* and *InputMax*
PressureDifference	5	bar	see above
InputMax	1	-	maximum input signal

Notes

The component VariableThrottle is a model of an adjustable fluid resistance with to a large extent linear shaped dependence of the *VolumeFlow* on the *PressureDifference p1-p2* connected to the component. It is parameterized over the hydraulic parameters *VolumeFlow* and *PressureDifference*.

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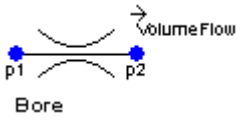
$$Q = \frac{\pi r^4}{8\eta l}(p_1 - p_2)$$

(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The relation between the *VolumeFlow* and the *PressureDifference p1-p2* is adjustable via an input signal. (VARIABLETHROTTLE)

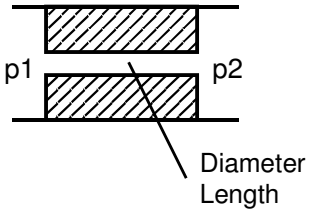
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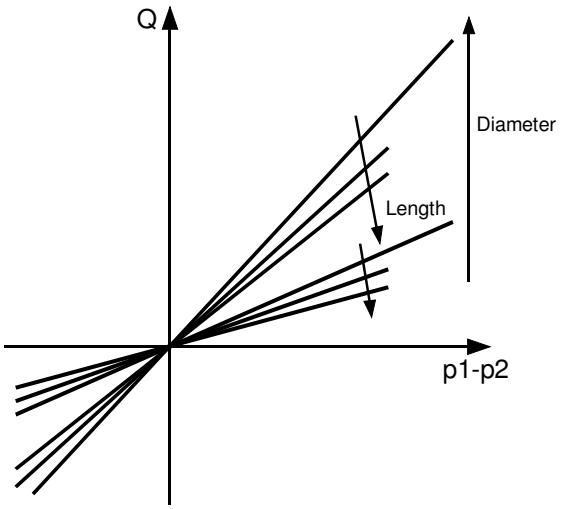
Bore



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the component(Q)

Parameters

Name	Value	Unit	Description
Diameter	1	mm	diameter of the bore
Length	10	mm	length of the bore
TDifference	0	K	Difference between local and system temperature
PressureDependency	0	0 No, 1 Yes	Consideration of the pressure dependend fluid properties

Notes

The component BORE is a model of a fluid resistance with to a large extent linear shaped dependence of the *VolumeFlow* on the pressure difference *p1-p2* connected to the component. It is parameterized over the geometric parameters *Diameter* and *Length*. The kinetic viscosity (*KinViscousity*) of the fluid and its density (*Rho*) are considered in their

temperature dependency and adjusted in the fluid options. The pressure dependend influence on the fluid properties can be considerd with the help of *the parameter PressureDependency*.

$$Q = \frac{\pi r^4}{8\eta l}(p_1 - p_2)$$

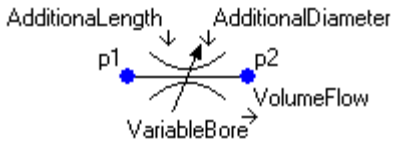
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The BORE is also available as a component whereas the geometry of the bore is adjustable via an input signal. (VARIABLEBORE).

In addition to the BORE, the component THROTTLE exists with the same, linear shaped characteristic, which however is parameterized over the hydraulic parameters *VolumeFlow* and *PressureDifference*.

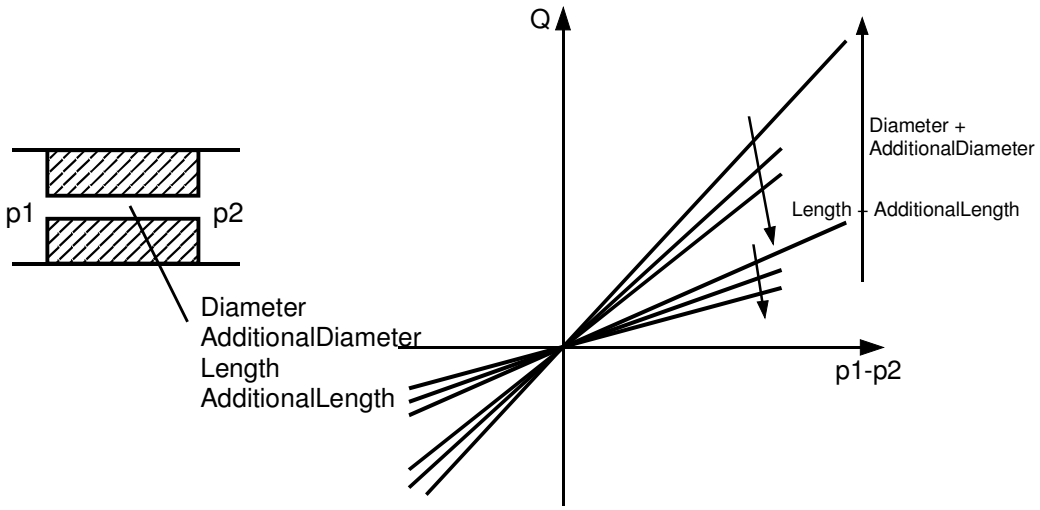
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VariableBore



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
AdditionalDiameter	In	mm	Signal input to vary the bore diameter during the simulation
AdditionalLenght	In	mm	Signal input to vary the bore length during the simulation
VolumeFlow	Out		flow through the component(Q)

Parameters

Name	Value	Unit	Description
Diameter	1	mm	diameter of the bore
Length	10	mm	length of the bore
Offset	0	Mm	Lenght offset of the bore
Sign	-	-	Algebraic sign of the bore lenght

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Name	Value	Unit	Description
TDifference	0	K	Difference between local and system temperature

Notes

The component VARIABLEBORE is a model of a fluid resistance with to a large extent linear shaped dependence of the *VolumeFlow* on the pressure *d*ifference *p1-p2* connected to the component. It is parameterized over the geometric parameters *Diameter* and *Length*.

$$Q = \frac{\pi r^4}{8\eta l}(p_1 - p_2)$$

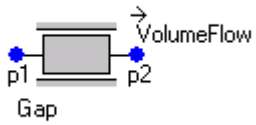
(Grundlagen der Fluidtechnik Teil1: Hydraulik, Murrenhoff)

The THROTTLE is also available as a component whereas the relation between the *Volume-Flow* and the *PressureDifference p1-p2* is adjustable via an input signal. (VARIABLETHROTTLE)

In addition to the BORE, the component THROTTLE exists with the same, linear shaped characteristic, which however is parameterized over the hydraulic parameters *VolumeFlow* and *PressureDifference*.

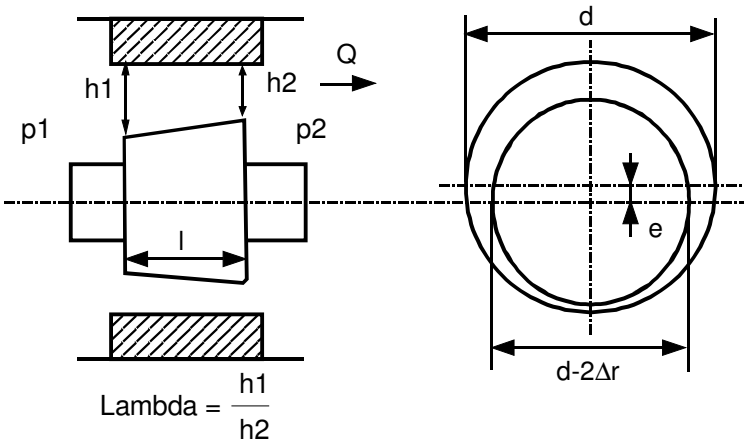
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Gap



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the component (Q)

Parameters

Name	Value	Unit	Description
Diameter	1	mm	see sketch (d)
Length	10	mm	see sketch (l)
GapHeight_p1	20	microm	Gap height h1 at p1
GapHeight_p2	20	microm	Gap height h2 at p1
Eccentricity	0	%	see sketch (e)
TDifference	0	K	difference between local and system temperature

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Notes

The component GAP describes an eccentric and conical ring gap. The calculation of this gap presupposes a Newton liquid.

The volume flow through the gap is calculated by following formula:

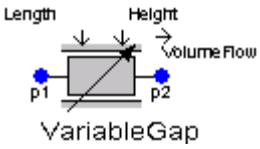
$$Q = \frac{d\pi\Delta p h_2^{\,3}}{12\eta l}\left[\frac{2\lambda^2}{1+\lambda} + (1+\lambda)\frac{3}{4}\varepsilon^2\right]$$

(www.fachwissen-dichtungstechnik.de)

The viscosity is adjusted through the central fluid parameter.

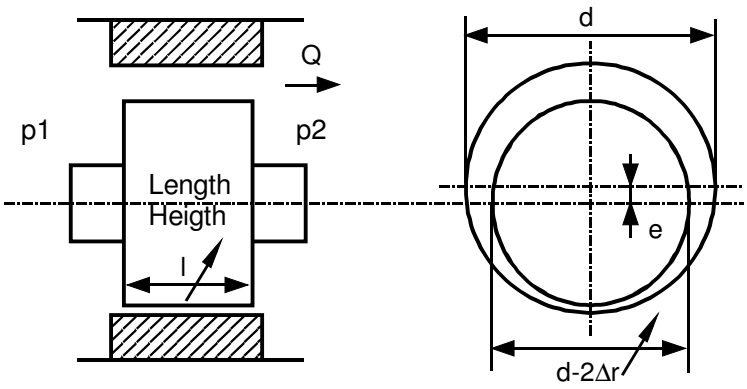
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VariableGap



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the component (Q)
Length	In	mm	Length of the Gap
Height	In	mm	Height of the Gap

Parameters

Name	Value	Unit	Description
Diameter	1	mm	Diameter of the gap
GapLength	10	mm	Length of the gap
GapHeight	20	microm	Height of the gap
Eccentricity	0	%	Offset between the cylinder walls and the gap
Offset	0	mm	Length offset
Sign	1		Algebraic sign of the length

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Name	Value	Unit	Description
Tdifference	0	K	difference between local and system temperature

Notes

The component VARIABLEGAP describes an excentric annular gap, whose calculation is based on the Newtonian fluid.

The volume flow through the VARIABLEGAP is calculated by the following equation:

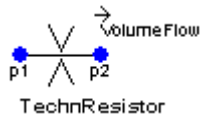
$$Q = \frac{d\pi\Delta r^3}{12\eta l}\left[1 + 1{,}5\left(\frac{e}{\Delta r}\right)^2\right](p_1 - p_2)$$

(Grundlagen der Fluidtechnik, Teil1: Hydraulik bei Professor Hubertus Murrenhoff)

The viscosity is adjusted in the fluid options. The geometry can be varied during the simulation.

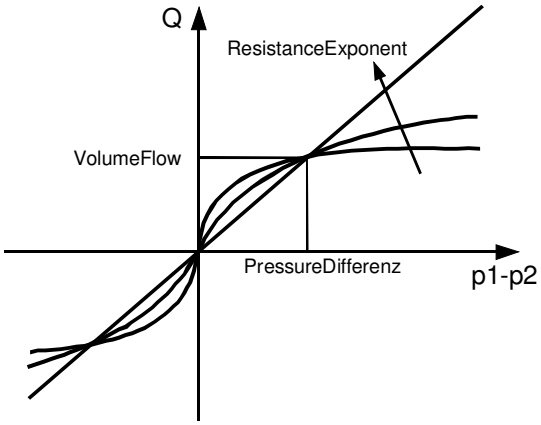
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TechnResistor



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the resistor

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the resistor
PressureDifference	5	bar	at *PressureDifference*
ResistanceExponent	1	-	exponent, that describes the flow in dependence on the applied pressure difference *p1 - p2*

Notes

With the component TECHNRESISTOR hybrid forms between linear and root shaped dependence of the pressure difference *p1 - p2* and the flow can be described. For linear dependence, the resistance exponent is controlled by 1, for root shaped dependence in the case of 0,5.

$$Q = \alpha_D A \sqrt{\frac{2}{\rho}} (p_1 - p_2)$$

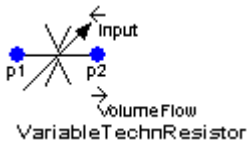
(Grundlagen der Fluidtechnik, Teil1: Hydraulik by Professor Hubertus Murrenhoff)

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The TECHNRESISTOR is also available as a component whereas the relation between the *VolumeFlow* and the *PressureDifference p1-p2* is adjustable via an input signal. (VARIABLETECHNRESISTOR)

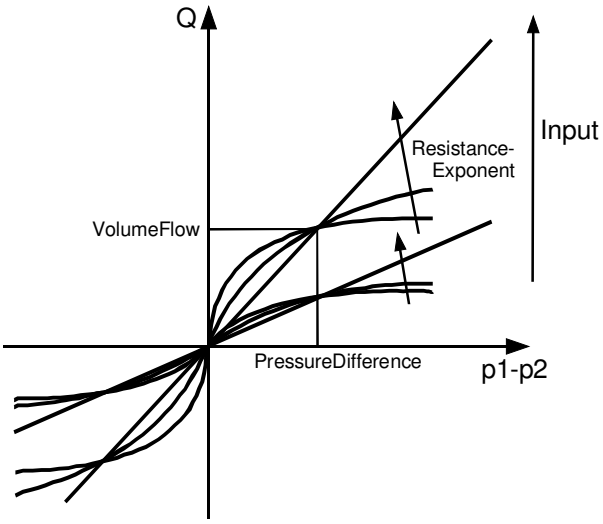
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VariableTechResistor



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
Input	In	-	input signal to adjust the resistor
VolumeFlow	Out		flow through the resistor

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the resistor
PressureDifference	5	bar	at *PressureDifference* and *InputMax*
ResistanceExponent	1	-	exponent, that describes the flow in dependence on the applied pressure difference *p1 - p2*
InputMax	1	-	maximum input signal

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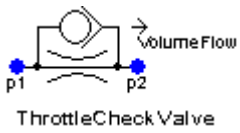
Notes

With the component TECHNRESISTOR hybrid forms between linear and root shaped dependence of the pressure difference *p1 - p2* and the flow can be described. For linear dependence, the resistance exponent is controlled by 1, for root shaped dependence in the case of 0,5.

The relation between the *VolumeFlow* and the *PressureDifference p1-p2* is adjustable via an input signal.

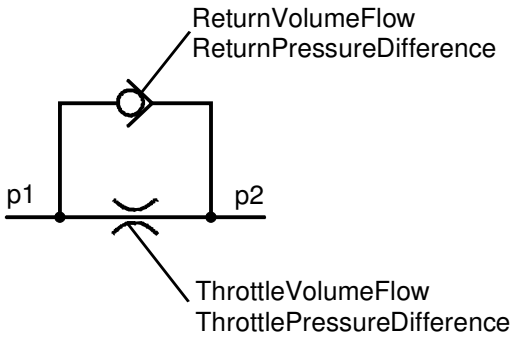
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ThrottleCheckValve



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the valve

Parameters

Name	Value	Unit	Description
ThrottleVolumeFlow	30	l/min	flow through the throttle at *ThrottlePressureDifference*
ThrottlePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	flow through the throttle check valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above

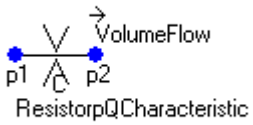
Notes

The component THROTTLECHECKVALVE is a model that combines a throttle and a check valve. If *p1* > *p2* the flow has to go through the throttle whereas if the pressure *p2* > *p1* it goes through the throttle and the check valve.

The flow characteristic of throttle and check valve is determined by the parameters *ThrottleVolumeFlow* and *ThrottlePressureDifference* as well as *ReturnVolumeFlow* and *ReturnPressureDifference*.

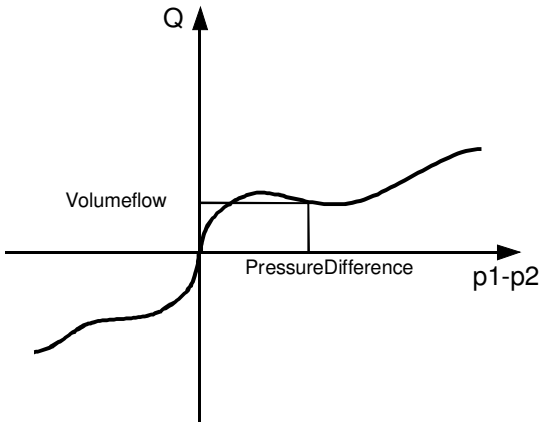
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ResistorpQCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
VolumeFlow	Out		flow through the component

Parameters

Name	Value	Unit	Description
pQCharacteristic	-1	-	look-up table of the volume-flow-pressure-function
Factor	1	-	stretch- or compress factor for the output values of the look-up table

Notes

With the component RESISTORPQCHARACTERISTIC arbitrary dependences of the pressure difference *p1 - p2* and the flow can be described. Flow values and pressure differences are stored into an one-dimensional look-up table and assigned to the parameter PQCHARACTERISTIC.

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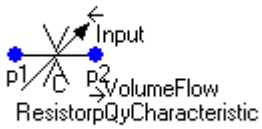
The component RESISTORPQCHARACTERISTIC allows to integrate e. g. a pressure flow curve which is measured on a test bench into the simulation.

The parameter FACTOR stretches or compresses the flow values of the look-up table.

If the pressure difference at the component is greater than the maximum- resp. minimum value of the look-up table, the defined flow value of the edge of the look-up table is constant. There is no extrapolation.

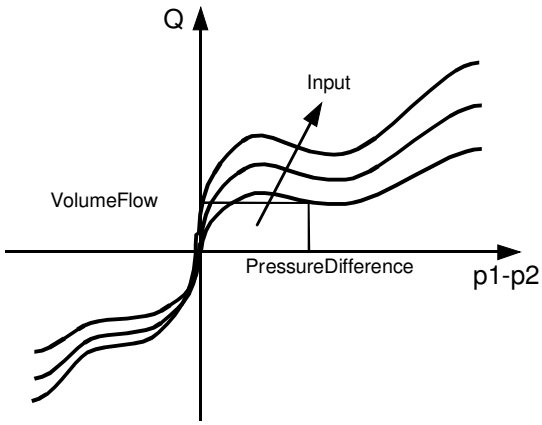
With the component TECHNRESISTORPQYCHARACTERISTIC another component is available to consider the dependence of the flow to an input stroke. In this way e. g. a measured valve characteristic can be integrated into the simulation.

ResistorpQyCharacteristic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure at side 1
p2	Hydr	bar	pressure at side 2
Volumeflow	Out		flow through the resistor

Parameters

Name	Value	Unit	Description
pQCharacteristic	-1	-	characteristic (2-dimensional) of the volume-flow-pressure-function
Factor	1	-	stretch- or compress/sprain factor to the state values of the characteristic area

Notes

The component TECHNRESISTORPQYCHARACTERISTIC arbitrary correlations between the dependences of the pressure difference *p1 - p2* and the flow can be described. Flow values,

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pressure differences and input signals are stored into a two-dimensional look-up table and assigned to the parameter PQCHARACTERISTIC.

The component RESISTORPQYCHARACTERISTIC enables to integrate f. e. a pressure flow curve which is measured on a test bed into the simulation. Is the spool stroke used as a input signal y of the adjustment the complete valve characteristic is considered.

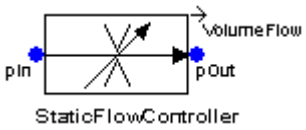
The parameter FAKTOR stretches or compresses/sprains the flow values of the characteristic.

Is the pressure difference at the component greater than the maximum- resp. minimum value of the characteristic area , the defined flow value at the edgepoint of the characteristic is distributed constantly. There is no extrapolation.

The component TECHNRESISTORPQCHARACTERISTIC is an another component only to consider the dependence of the flow to the pressure difference. In this way f. e. an on a test bed measured pressure limit valve or check valve will be integrated into the simulation.

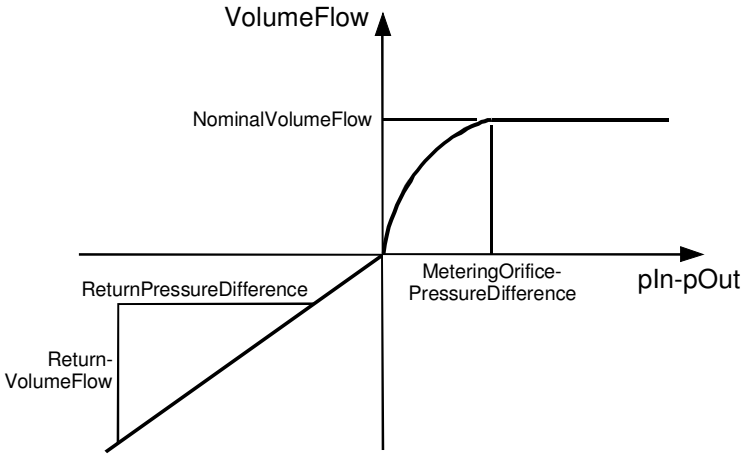
Flow Valves

StaticFlowController



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pOut	Hydr	bar	pressure at outlet side
pIn	Hydr	bar	pressure at inlet side
VolumeFlow	Out		flow through the component

Parameters

Name	Value	Unit	Description
NominalVolumeFlow	10	l/min	set value for the flow
MeteringOrificePressureDif-ference	5	bar	minimum pressure difference at *NominalVolumeFlow*
ReturnVolumeFlow	30	l/min	flow through the component at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above

Notes

The component STATICFLOWCONTROLLER does not provide a model of the physical design of a flow controller but only copies its characteristic features. Thus, physical parameters e.g. inertia momentum are not taken into consideration.

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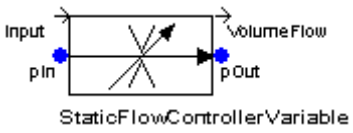
With a pressure difference of *pIn - pOut > MeteringOrificePressureDifference* the flowing flow becomes limited onto the debit volume flow.

In the case of a negative pressure difference (*pIn - pOut <0*), the controller works like a constant throttle, that is determined by the parameter *ReturnVolumeFlow* at *ReturnPressureDifference*. In the intermediate field (*0 <pIn - pOut < MeteringOrificePressureDifference*) the characteristic of the controller corresponds with the characteristic of an orifice, that is parameterized with the parameter *NominalVolumeFlow* in the case of *MeteringOrificePressureDifference*.

The STATICFLOWCONTROLLER is also available as a component whereas the *VolumeFlow* is adjustable via an input signal. (STATICFLOWCONTROLLERVARIABLE)

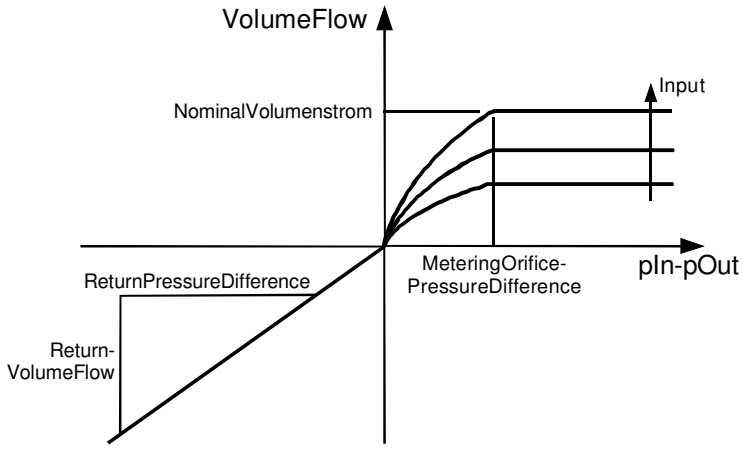
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StaticFlowControllerVariable



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pOut	Hydr	bar	pressure at outlet side
pIn	Hydr	bar	pressure at inlet side
Input	In	-	signal to adjust the flow
VolumeFlow	Out		flow through the component

Parameters

Name	Value	Unit	Description
NominalVolumeFlow	10	l/min	set value for the flow
MeteringOrificePressureDifference	5	bar	minimum PressureDifference at *NominalVolumeFlow*
InputMax	1	-	maximum input signal
ReturnVolumeFlow	30	l/min	flow through the component at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above

Notes

The component STATICFLOWCONTROLLERVARIABLE does not provide a model of the physical design of a flow controller but only copies its characteristic features. Thus, physical parameters e.g. inertia momentum are not taken into consideration.

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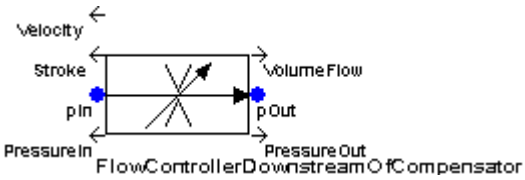
With a pressure difference of *pIn - pOut > MeteringOrificePressureDifference* the flowing flow becomes limited onto the debit volume flow.

In the case of a negative pressure difference (*pIn - pOut <0*), the controller works like a constant throttle, that is determined by the parameter *ReturnVolumeFlow* at *ReturnPressureDifference*. In the intermediate field (*0 <pIn - pOut < MeteringOrificePressureDifference*) the characteristic of the controller corresponds with the characteristic of an orifice, that is parameterized with the parameter *NominalVolumeFlow* in the case of *MeteringOrificePressureDifference*.

The required value of the *VolumeFlow* is adjustable via an input signal.

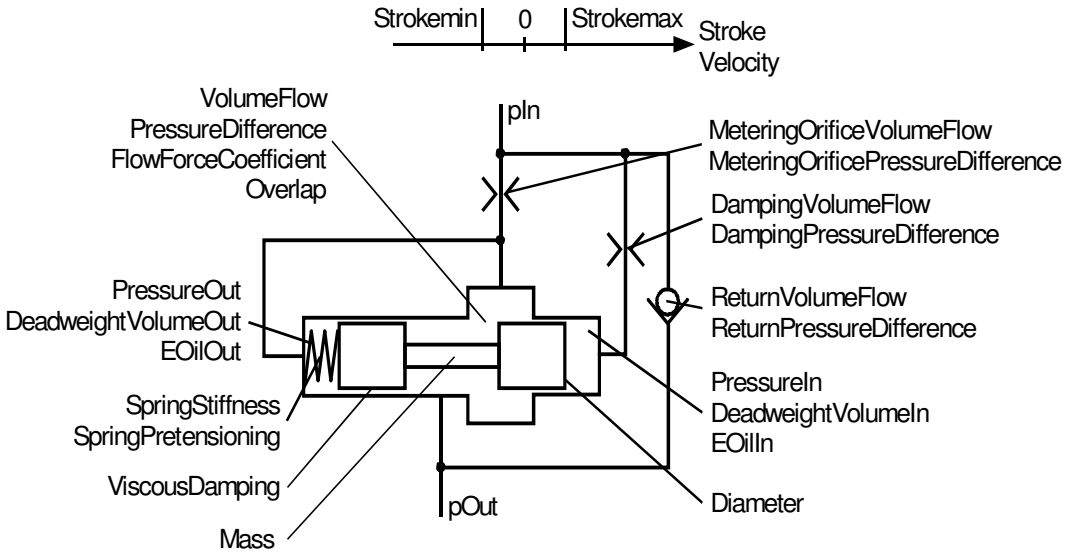
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FlowControllerDownstreamOfCompensator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at inlet side
pOut	Hydr	bar	pressure at the side of the controlled flow
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
PressureOut	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose

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Name	Type	Unit	Description
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlow	Out	l/min	controlled flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the control valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	flow at the metering orifice at *MeteringOrifice-PressureDifference*
MeteringOrificePressureDifference	5	bar	s.a
ReturnVolumeFlow	30	l/min	flow through the check valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above
DampingVolumeFlow	30	l/min	flow through the damping orifice at *DampingPressureDifference*
DampingPressureDifference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum stroke of the spool
Strokemin	0	mm	maximum stroke of the spool in negative direction
DeadWeightVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
DeadWeightVolumeOut	0.01	l	dead volume between spool and metering orifice at *Strokemin*
Diameter	10	mm	diameter of the valve spool

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Name	Value	Unit	Description
EOilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve
EOilOut	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the outlet side of the valve

Notes

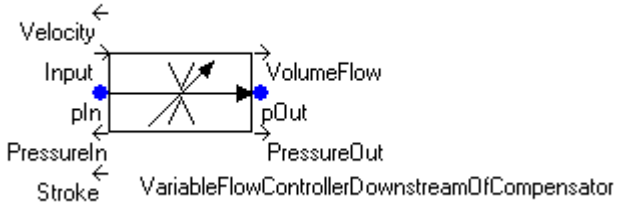
The component FLOWCONTROLLERDOWNSTREAMOFCOMPENSATOR is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* - *pIn* a constant flow. Since the component has no reservoir outlet the surplus of flow has to leave the system over a pressure relive valve.

Through the parameter *EOilIn* and *EOilOut* different wall-thicknesses can be considered in the pipes between valve spool and the orifices.

With VARIABLEFLOWCONTROLLERDOWNSTREAMOFCOMPENSATOR a component is available with which the demand value of the volume flow can be adjusted variable via an input signal.

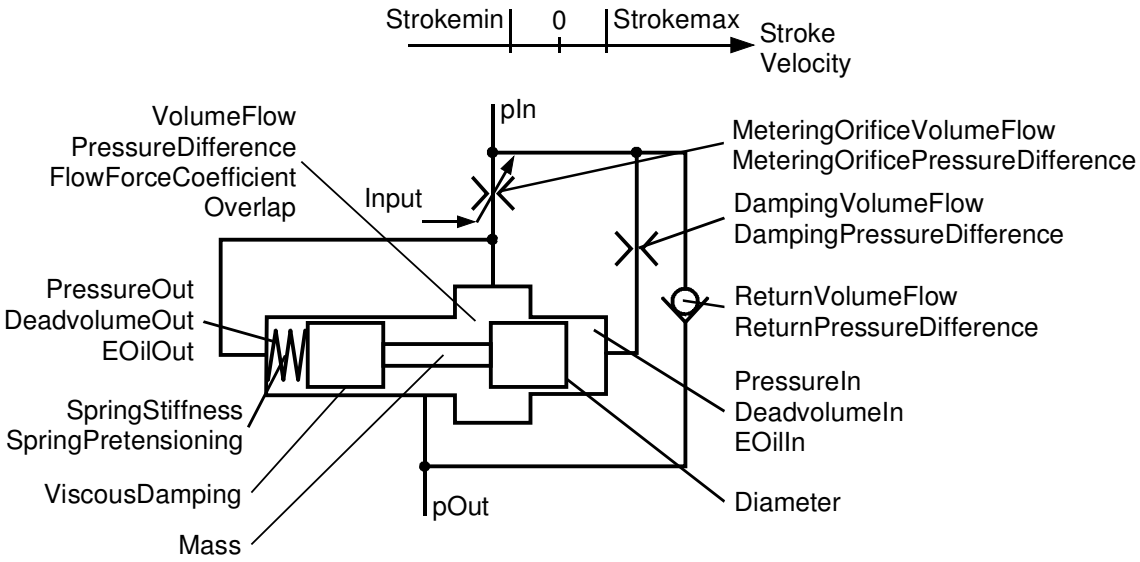
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VariableFlowControllerDownstreamOfCompensator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	pressure at the side of the controlled flow
Input	In	-	input signal
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
PressureOut	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose

Name	Type	Unit	Description
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlow	Out	l/min	controlled flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the control valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	flow through the metering orifice at *MeteringOrifice-PressureDifference*
MeteringOrificePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	flow through the return valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above
DampingVolumeFlow	30	l/min	flow through the damping orifice at *DampingPressureDifference*
DampingPressureDifference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
InputMax	1		Maximum input signal for the metering orifice
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction

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Name	Value	Unit	Description
DeadweightVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
DeadweightVolumeOut	0.01	l	dead volume between spool and metering orifice at *Strokemin*
Diameter	10	mm	diameter of the valve spool
EoilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve
EoilOut	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the outlet side of the valve

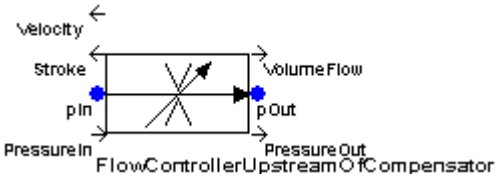
Notes

The component VARIABLEFLOWCONTROLLERDOWNSTREAMOFCOMPENSATOR is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* - *pIn* a constant flow. The demand value of the volume flow can be adjusted variable via the INPUT. Since the component has no reservoir outlet the surplus of flow has to leave the system over a pressure relieve valve.

Through the parameter *EOilIn* and *EOilOut* different wall-thicknesses can be considered in the pipes between valve spool and the orifices.

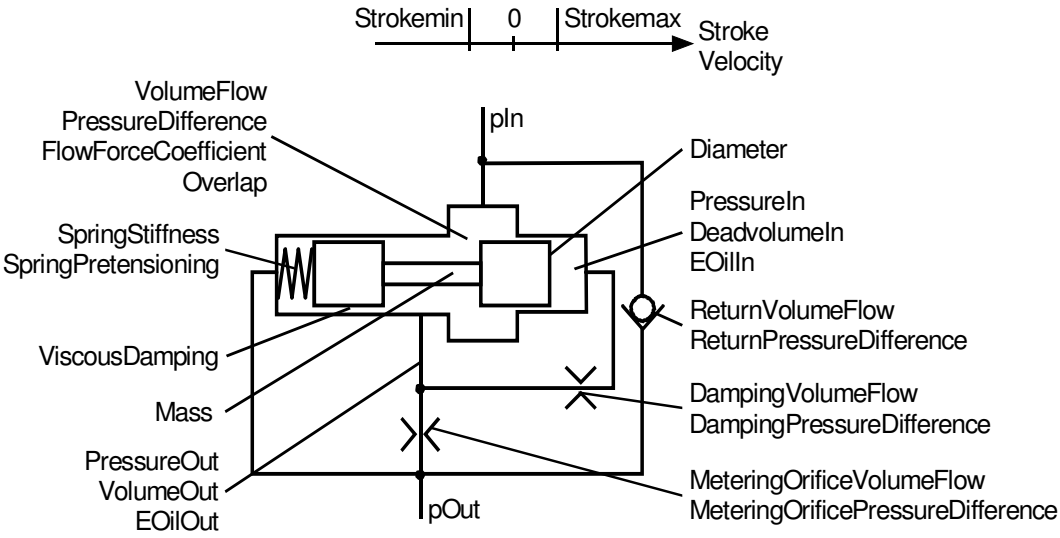
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FlowControllerUpstreamOfCompensator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	pressure at the side of the controlled flow
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
PressureOut	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose

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Name	Type	Unit	Description
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlow	Out	l/min	controlled flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the control valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	flow through the metering orifice at *MeteringOrificePressureDifference*
MeteringOrificePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	volume flow at the return valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above
DampingVolumeFlow	30	l/min	volume flow at the damping orifice at *DampingPressureDifference*
DampingPressureDifference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
Diameter	10	mm	Piston diameter
VolumeOut	0.01	l	dead volume between valve metering orifice and damping orifice

Name	Value	Unit	Description
DeadWeightVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
EOilOut	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the outlet side of the valve
EOilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve

Notes

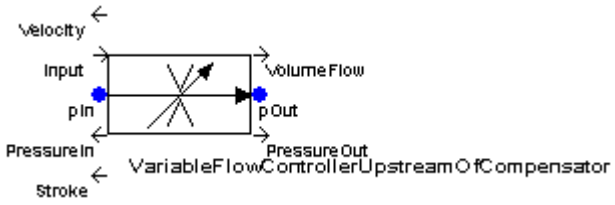
The component FLOWCONTROLLERUPSTREAMOFCOMPENSATOR is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* - *pIn* a constant flow. Since the component has no reservoir outlet the surplus of flow has to leave the system over a pressure relive valve.

Through the parameter *EOilIn* and *EOilOut* different wall-thicknesses can be considered in the pipes between valve spool and the orifices.

With VARIABLEFLOWCONTROLLERUPSTREAMOFCOMPENSATOR a component is available with which the demand value of the volume flow can be adjusted variable via an input signal.

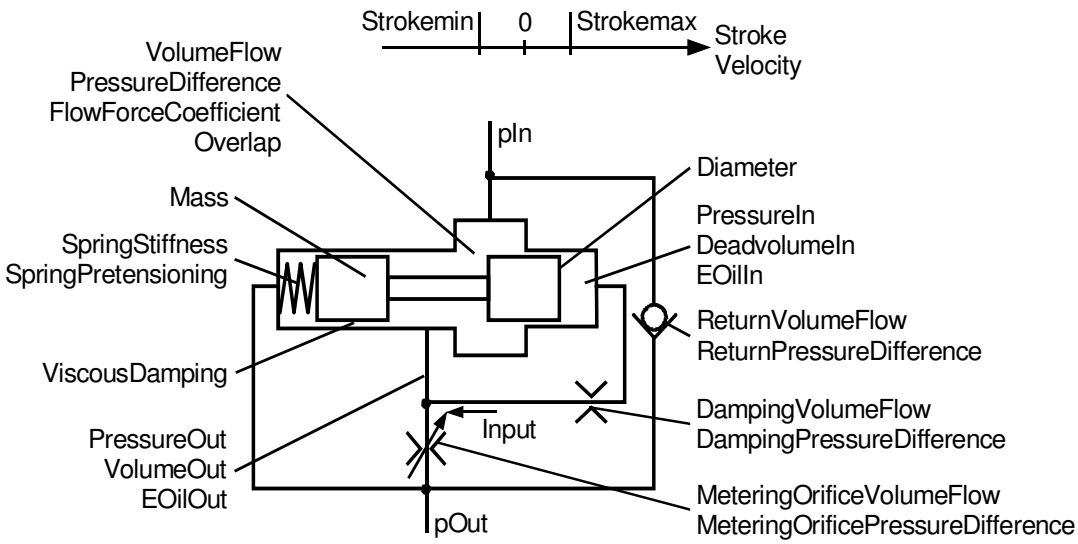
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VariableFlowControllerUpstreamOfCompensator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	pressure at the side of the controlled flow
Input	In	-	input signal
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
PressureOut	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose

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Name	Type	Unit	Description
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlow	Out	l/min	controlled flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the control valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	flow through the metering orifice at *MeteringOrifice-PressureDifference*
MeteringOrificePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	flow through the return valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above
DampingVolumeFlow	30	l/min	flow through the damping orifice at *DampingPressureDifference*
DampingPressure Difference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
InputMax	1	-	maximum input signal
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
Diameter	10	mm	diameter of the valve spool
VolumeOut	0.001	l	dead volume between spool and metering orifice at *Strokemin*

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Name	Value	Unit	Description
DeadweightVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
EoilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve
EoilOut	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the outlet side of the valve

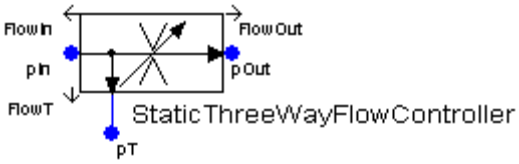
Notes

The component VARIABLEFLOWCONTROLLERUPSTREAMOFCOMPENSATOR is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* - *pIn* a constant flow. The demand value of the volume flow can be adjusted variable via an input signal. Since the component has no reservoir outlet the surplus of flow has to leave the system over a pressure relive valve.

Through the parameter *EOilIn* and *EOilOut* different wall-thicknesses can be considered in the pipes between valve spool and the orifices.

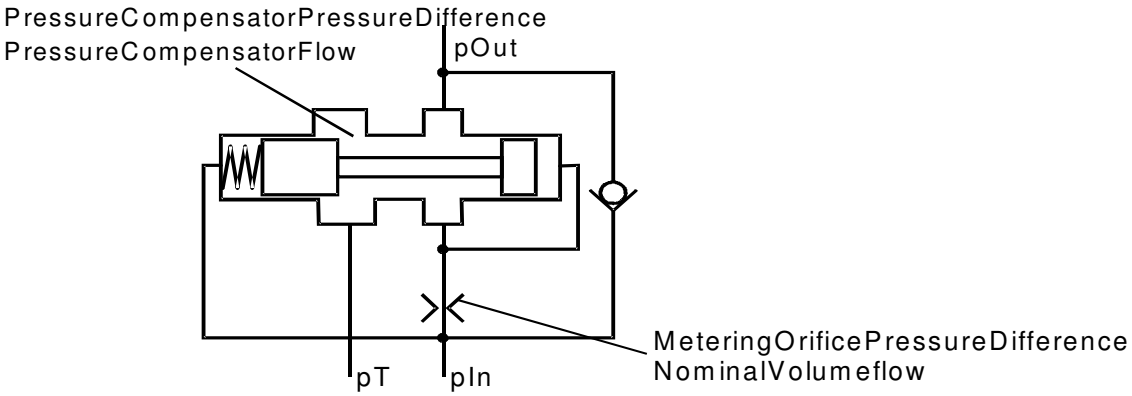
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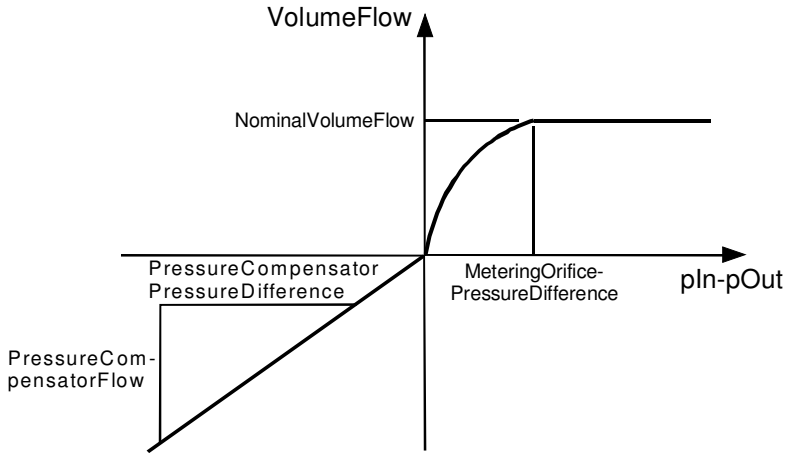
StaticThreeWayFlowController



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	Pressure at the side of the controlled flow
pT	Hydr	bar	Reservoir pressure
FlowIn	In	-	Input volume flow
FlowOut	Out	l/min	Output volume flow

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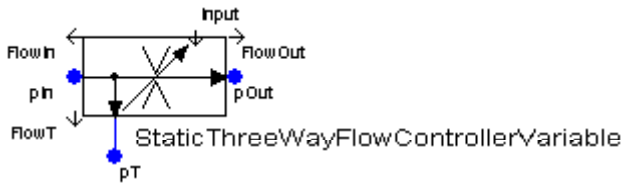
Name	Type	Unit	Description
FlowT	Out	l/min	Volumeflow drain

Parameters

Name	Value	Unit	Description
NominalVolumeFlow	10	l/min	Set value of Volume flow
MeteringOrificePressureDifference	5	bar	volume flow through the metering orifice at *MeteringOrificePressureDifference*
PressureCompensatorFlow	30	l/min	Flow compensating the Pressure
PressureCompensatorPressureDifference	1	bar	Pressure to maintain the Pressure difference

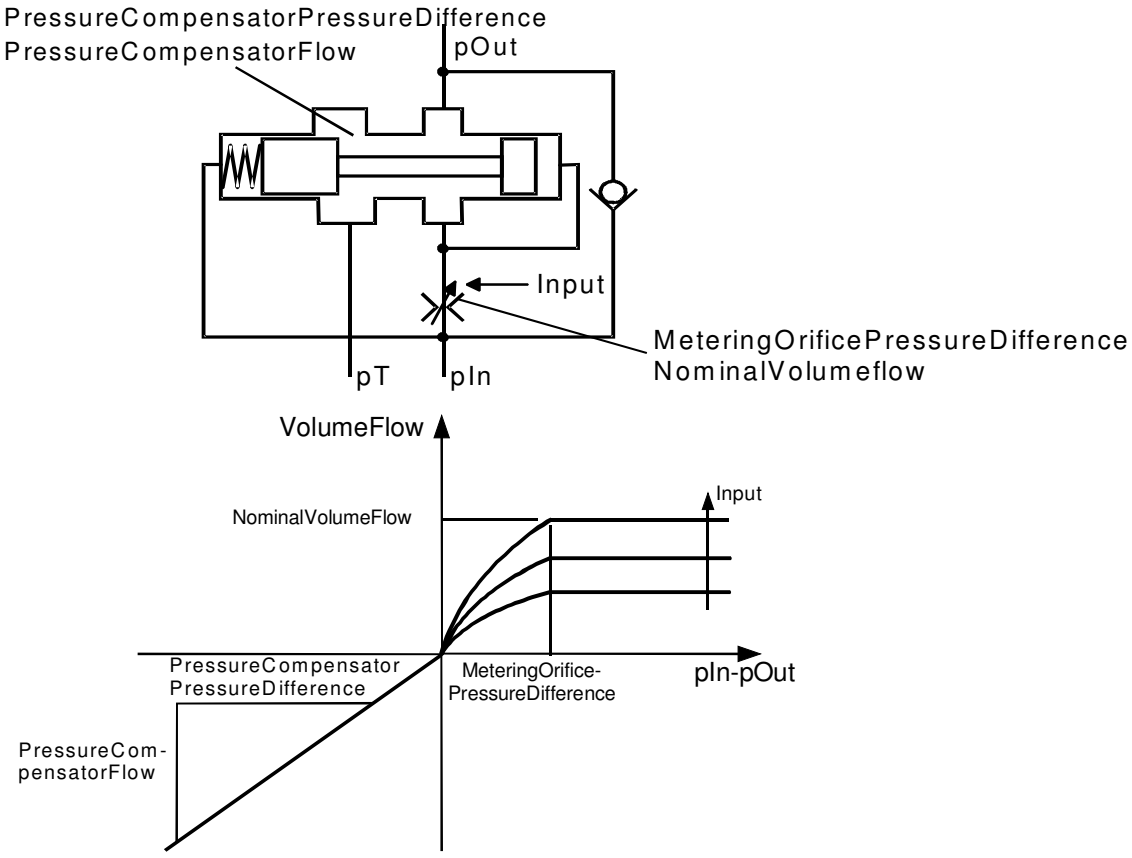
Notes

StaticThreeWayFlowControllerVariable



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	Pressure at the side of the controlled flow
pT	Hydr	bar	Reservoir pressure
FlowIn	In	-	Input Volumeflow
FlowOut	Out	-	Outlet VolumeFlow

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Name	Type	Unit	Description
FlowT	Out	-	Volumeflow at the drain
Input	In	-	Input signal

Parameters

Name	Value	Unit	Description
NominalVolumeFlow	10	l/min	Set value of Volume flow
MeteringOrificePressureDifference	5	bar	volume flow through the metering orifice at *MeteringOrifice-PressureDifference*
PressureCompensatorFlow	30	l/min	Flow compensating the Pressure
PressureCompensatorPressureDifference	1	bar	Pressure to maintain the Pressure difference
InputMax	1	1	Maximum input signal

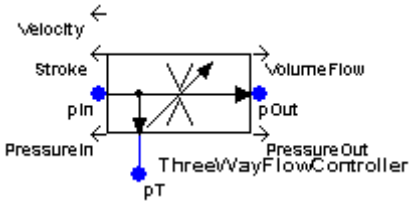
Notes

The component STATICTHREEWAYFLOWCONTROLLERVARIABLE is a combination of a neteringorifice and a pressure compensatior, which delivers independent of the changing pressure difference pout-pIn a constant flow. The surplus leaves in *FlowT*.

The value of the NominalVolumeFlow can be adjusted with the *Input*.

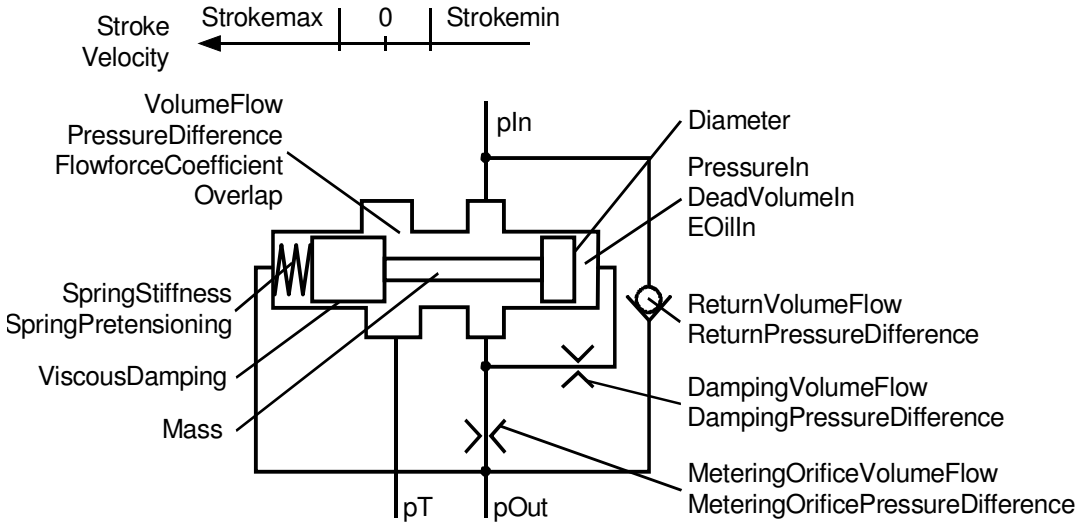
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ThreeWayFlowController



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	pressure at the side of the controlled flow
pT	Hydr	bar	reservoir pressure
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlow	Out	l/min	controlled flow

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	volume flow through the metering orifice at *MeteringOrificePressureDifference*
MeteringOrificePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	flow through the return valve at *ReturnPressureDifference*
ReturnPressureDifference	5	bar	see above
DampingVolumeFlow	30	l/min	flow through the damping orifice at *DampingPressureDifference*
DampingPressureDifference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
DeadVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
Diameter	10	mm	Valve spool diameter
EoilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve

Notes

The component THREEWAYFLOWCONTROLLER is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* -

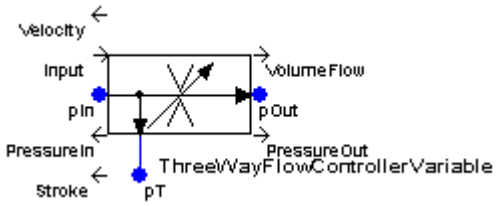
pIn a constant flow. Since the component has a reservoir outlet the surplus of flow leaves the system over this outlet.

Through the parameter *EOilIn* a different wall-thickness can be considered in the pipe between valve spool and the damping orifice.

With THREEWAYFLOWCONTROLLERVARIABLE a component is available with which the demand value of the volume flow can be adjusted variable via an input signal.

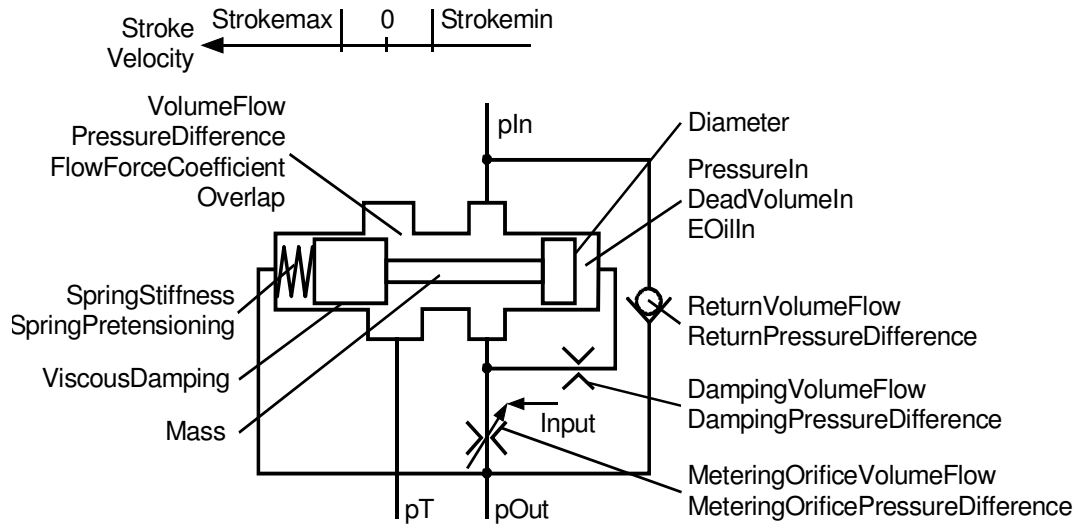
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ThreeWayFlowControllerVariable



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pIn	Hydr	bar	pressure at the upstream side
pOut	Hydr	bar	pressure at the side of the controlled flow
pT	Hydr	bar	reservior pressure
Input	In	-	input signal
PressureIn	Out	bar	internal auxiliary value (pressure inside the component), which can be displayed for control purpose
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose

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Name	Type	Unit	Description
VolumeFlow	Out	l/min	controlled flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*
PressureDifference	5	bar	see above
MeteringOrificeVolumeFlow	30	l/min	flow through the metering orifice at *MeteringOrifice-PressureDifference*
MeteringOrificePressureDifference	5	bar	see above
ReturnVolumeFlow	30	l/min	volume flow at the return valve at *ReturnPressureDifference*
ReturnPressure-Difference	5	bar	see above
DampingVolumeFlow	30	l/min	flow through the damping orifice at *DampingPressureDifference*
DampingPressureDifference	5	bar	see above
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Overlap	0	%	relative overlap of the metering edge
ViscousDamping	10	Ns/m	velocity dependent friction of the spool
SpringStiffness	5	N/mm	stiffness of the return spring of the spool
SpringPretensioning	10	mm	spring pre-tensioning at *Strokemax*
Mass	0.2	kg	mass of the spool
Strokemax	10	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
DeadVolumeIn	0.01	l	dead volume between spool and metering orifice at *Strokemax*
Diameter	10	mm	Valve spool diameter
EoilIn	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure at the inlet side of the valve
InputMax	1	-	maximum input signal

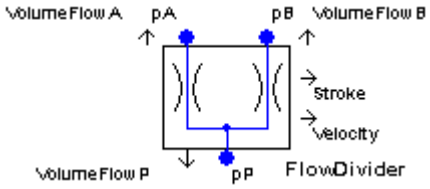
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Notes

The component THREEWAYFLOWCONTROLLERVARIABLE is a combination of metering orifice and pressure compensator, which delivers independent of the changing pressure difference *pOut* - *pIn* a constant flow. The demand value of the volume flow can be adjusted variable via an input signal. Since the component has a reservoir outlet the surplus of flow leaves the system over this outlet.

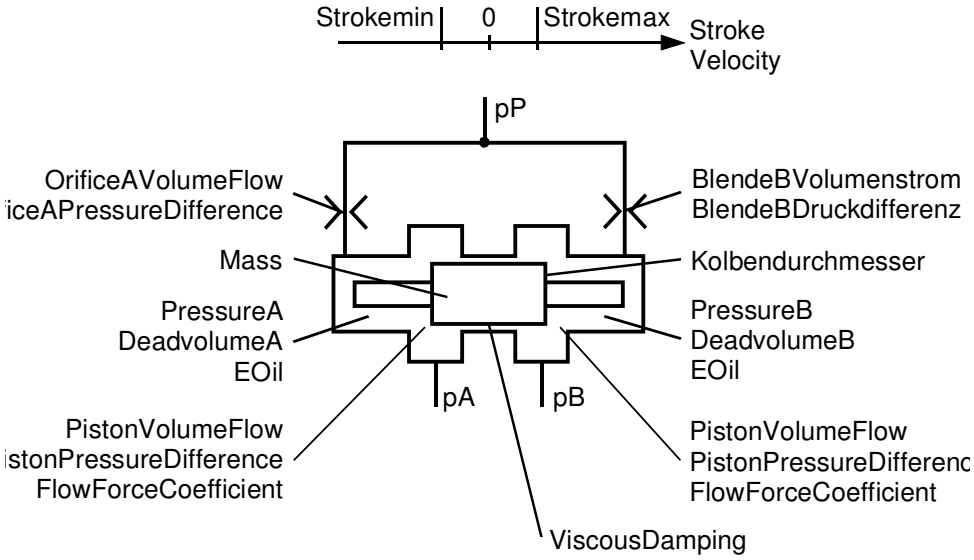
Through the parameter *EOilIn* a different wall-thickness can be considered in the pipe between valve spool and the damping orifice.

FlowDivider



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
PressureA	Out	bar	pressure behind orifice A
PressureB	Out	bar	pressure behind orifice B
Stroke	Out	mm	internal auxiliary value (stroke of the spool), which can be displayed for control purpose
Velocity	Out	m/s	internal auxiliary value (velocity of the spool), which can be displayed for control purpose
VolumeFlowP	Out	l/min	flow through connector P
VolumeFlowA	Out	l/min	flow through connector A
VolumeFlowB	Out	l/min	flow through connector B

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Parameters

Name	Value	Unit	Description
PistonVolumeFlow	30	l/min	flow through the valve at *PistonPressureDifference* (Side A and B)
PistonPressureDifference	5	bar	see above
OrificeAVolumeFlow	30	l/min	flow through the orifice A at *OrificeAPressureDifference*
OrificeAPressureDifference	5	bar	see above
OrificeBVolumeFlow	30	l/min	flow through the orifice B at *OrificeBPressureDifference*
OrificeBPressureDifference	5	bar	see above
Strokemax	2	mm	maximum spool stroke
Strokemin	-2	mm	maximum spool stroke in negative direction
DeadvolumeA	0.1	l	dead volume between the spool and the orifice A at *Strokemin*
DeadvolumeB	0.1	l	dead volume between the spool and the orifice B at *Strokemax*
Eoil	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure between the orifices and the valve
ViscousDamping	10	Ns/m	velocity depended friction at the spool
FlowForceCoefficient	0	N/bar/mm	coefficient for the flow forces calculation
Pistondiameter	10	mm	diameter of the piston
Mass	0.2	kg	mass of the spool

Notes

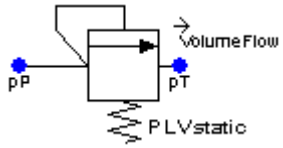
The component FLOWDIVIDER is a model of a flow divider, which divides the incoming flow (*VolumeFlowP*) according to the throttle principle into two flows (*VolumeFlowA* and *VolumeFlowB*). The ratio of the flows is determined by the orifices and to a large extent independent of the pressure difference *pA* and *pB*.

Through the parameter *EOil* a different wall-thicknesses can be considered in the pipe between valve spool and the damping orifice.

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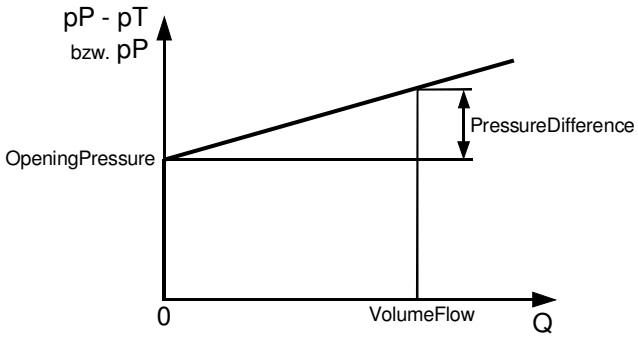
Pressure Valves

PLVstatic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pT	Hydr	bar	reservoir pressure
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at a *PressureDifference*
PressureDifference	5	bar	see above
OpeningPressure	200	bar	pressure required to open the valve
Balanced	1	-	see notes

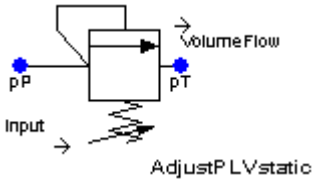
Notes

The PLVSTATIC is a model of a direct controlled pressure limiting valve without dynamic characteristics. For all pressures exceeding opening pressure the valve opens and flow flows through the valve. The flow increases linear to the pressure difference (*pP* - *pT* rep. *pP*).
If the valve is balanced (*Balanced* = 1) the valve opens if the supply pressure *pP* exceeds the opining pressure (Opening condition: *pP* > *OpeningPressure*). Is the valve not bal-

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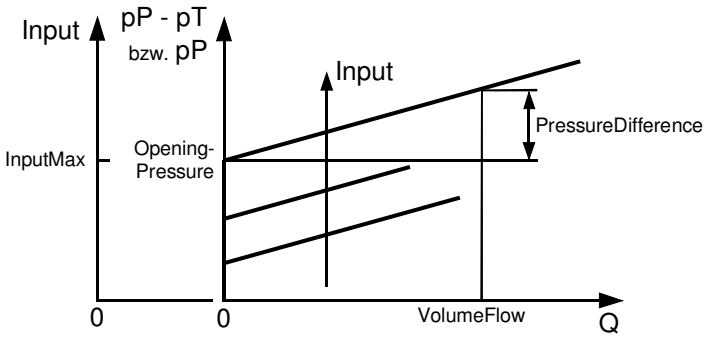
anced (*Balanced* = 0) the pressure *pT* is considered (Opening condition: *pP* - *pT* > *OpeningPressure*).
The component part PLVSTATIC is no model of a pressure limiting valve according to its physical structure. It merely represents the characteristic behavior of a pressure limiting valve. Therefore dynamic effects such as forces due to inertia will not be represented.
In order to chance the opening pressure during the simulation choose the adjustable pressure limiting valve (ADJUSTPLVSTATIC). If you want to look at dynamic effects chose the PLVDIRECT.

AdjustPLVstatic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pT	Hydr	bar	reservoir pressure
Input	In	-	input signal
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*
PressureDifference	5	bar	see above
OpeningPressure	200	bar	pressure required to open the valve at *InputMax*
InputMax	1	-	maximum input signal
Balanced	1	-	see notes

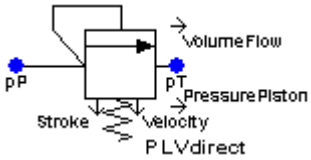
Notes

The component AdjustPLVstatic is a model of a direct controlled pressure limiting valve without dynamic characteristics. Be means of an input signal the opening pressure can be adjusted during the simulation. For all pressures exceeding opening pressure the valve opens and flow flows through the valve. The flow increases linear to the pressure difference (*pP - pT* rep. *pP*).

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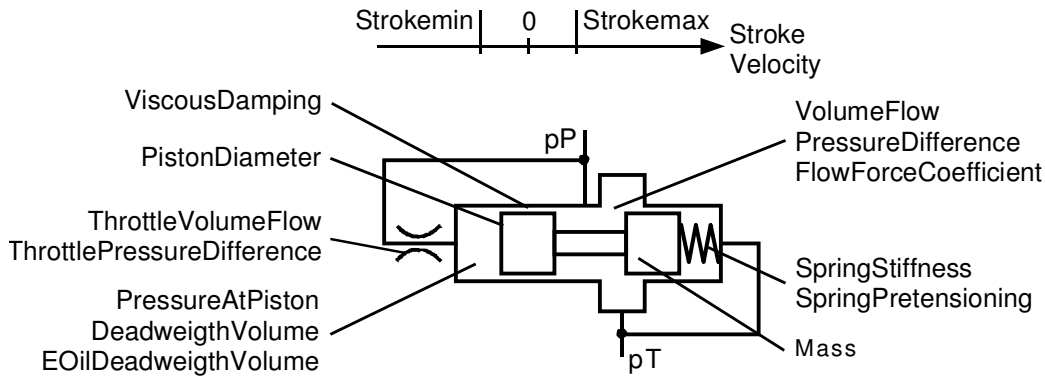
If the valve is balanced (*Balanced* = 1) the valve opens if the supply pressure *pP* exceeds the opining pressure (Opening condition: *pP* > *OpeningPressure* · *Input*). Is the valve not balanced (*Balanced* = 0) the pressure *pT* is considered (Opening condition: *pP* - *pT* > *OpeningPressure* · *Input*).
The component part *AdjustPLVstatic* is no model of a pressure limiting valve according to its physical structure. It merely represents the characteristic behavior of a pressure limiting valve. Therefore dynamic effects such as forces due to inertia will not be represented.

PLVdirect



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pT	Hydr	bar	reservoir pressure
PressurePiston	Out		pressure behind the throttle (internal auxiliary value which can be displayed for control purposes)
Stroke	Out	mm	stroke of the valve spool (internal auxiliary value which can be displayed for control purposes)
Velocity	Out	m/s	velocity of the valve spool (internal auxiliary value which can be displayed for control purposes)
VolumeFlow	Out	l/min	volume flow away

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*

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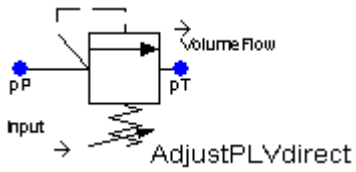
Name	Value	Unit	Description
PressureDifference	5	bar	see above
ThrottleVolumeFlow	5	l/min	flow through the throttle at *ThrottlePressureDifference*
ThrottlePressure-Difference	5	bar	see above
SpringStiffness	60	N/mm	stiffness of the spring
SpringPretensioning	6.5	mm	pre-tensioning of the spring at *Stroke* = *Strokemin*
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	2	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
ViscousDamping	10	Ns/m	velocity dependent friction at the valve spool
Mass	0.4	kg	mass of the valve spool
PistonDiameter	5	mm	diameter of the piston
Deadweight	0.1	l	deadweight volume between throttle and valve spool
EoilDeadweight	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to actual pressure and applied to the pressure equation of the dead weight volume.
Balanced	0	-	see notes

Notes

The component PLVDIRECT is a model of a direct controlled pressure limiting valve according to its physical structure.

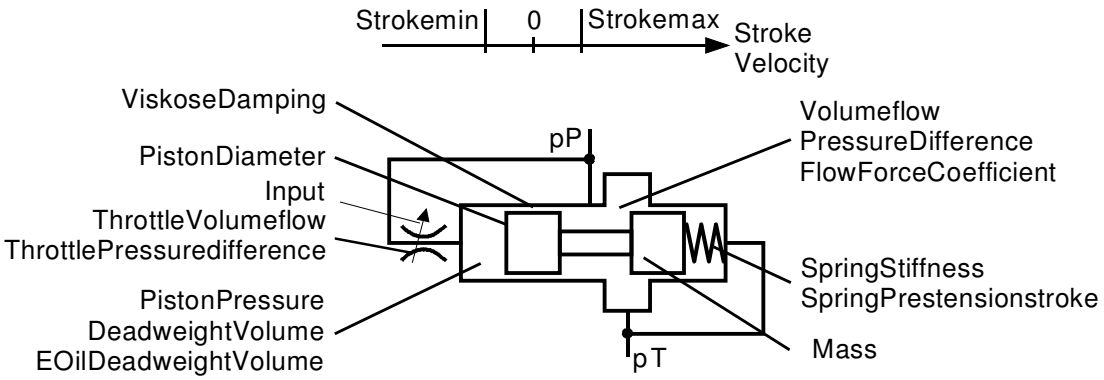
For all pressures exceeding opening pressure (*pP* - *pT* rep. *pP*) the valve opens and volume flow away from the valve. The opening pressure is adjustable by means of the parameters SpringStiffness and SpringPretensioning.
If the valve is balanced (*Balanced* = 1) the valve opens if the supply pressure *pP* exceeds the opining pressure (Opening condition: *pP* > *OpeningPressure*). Is the valve not balanced (*Balanced* = 0) the pressure *pT* is considered (Opening condition: *pP* - *pT* > *OpeningPressure*).
By means of the parameter EoilDeadweight it is possible to achieve a different compressibility of the dead weight volume between throttle and valve spool.

AdjustPLVdirect



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pT	Hydr	bar	reservoir pressure
PressurePiston	Out		pressure behind the throttle (internal auxiliary value which can be displayed for control purposes)
Stroke	Out	mm	stroke of the valve spool (internal auxiliary value which can be displayed for control purposes)
Velocity	Out	m/s	velocity of the valve spool (internal auxiliary value which can be displayed for control purposes)
VolumeFlow	Out	l/min	volume flow away

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*

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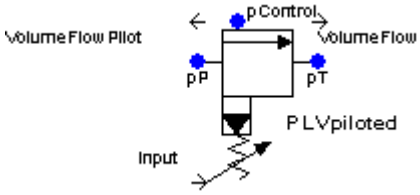
Name	Value	Unit	Description
PressureDifference	5	bar	see above
ThrottleVolumeFlow	5	l/min	flow through the throttle at *ThrottlePressureDifference*
ThrottlePressure-Difference	5	bar	see above
SpringStiffness	60	N/mm	stiffness of the spring
SpringPretensioning	6.5	mm	pre-tensioning of the spring at *Stroke* = *Strokemin*
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation
Strokemax	2	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
ViscousDamping	10	Ns/m	velocity dependent friction at the valve spool
Mass	0.4	kg	mass of the valve spool
PistonDiameter	5	mm	diameter of the piston
Deadweight	0.1	l	deadweight volume between throttle and valve spool
EoilDeadweight	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to actual pressure and applied to the pressure equation of the dead weight volume.
Balanced	0	-	see notes

Notes

The component PLVDIRECT is a model of a direct controlled pressure limiting valve according to its physical structure.

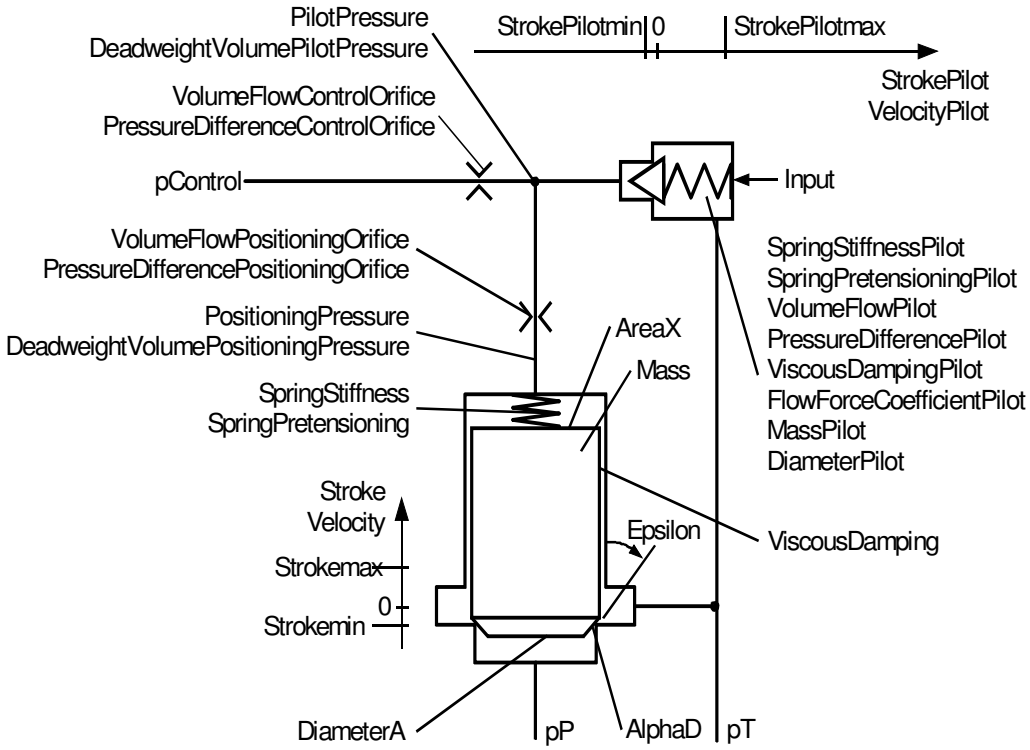
For all pressures exceeding opening pressure (*pP* - *pT* rep. *pP*) the valve opens and volume flow away from the valve. The opening pressure is adjustable by means of the parameters SpringStiffness and SpringPretensioning.
If the valve is balanced (*Balanced* = 1) the valve opens if the supply pressure *pP* exceeds the opining pressure (Opening condition: *pP* > *OpeningPressure*). Is the valve not balanced (*Balanced* = 0) the pressure *pT* is considered (Opening condition: *pP* - *pT* > *OpeningPressure*).
By means of the parameter EoilDeadweight it is possible to achieve a different compressibility of the dead weight volume between throttle and valve spool.

PLVpiloted



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pT	Hydr	bar	reservoir pressure
pControl	Hydr	bar	control pressure
Input	In	mm	input signal to adjust the spring pre-load of the pilot stage.
PositioningPressure	Out	bar	pressure applied to the spring side area of the spool.

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Name	Type	Unit	Description
PilotPressure	Out	bar	pressure between the orifices and the pilot stage (internal auxiliary value which can be displayed for control purposes).
Stroke	Out	mm	spool stroke
Velocity	Out	m/s	spool velocity
StrokePilot	Out	mm	stroke of the pilot valve spool (internal auxiliary value which can be displayed for control purposes).
VelocityPilot	Out	m/s	velocity of the pilot valve spool (internal auxiliary value which can be displayed for control purposes)
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
AlphaD	0.6	-	flow coefficient
Epsilon	30	deg	flow angle
Strokemax	5	mm	maximum stroke of the main valve spool
Strokemin	0	mm	maximum stroke of the main valve spool in negative direction
SpringStiffness	2	N/mm	stiffness of the spring of the main valve
SpringPretensioning	2	mm	spring pretension of the main valve at *Strokemin* (idle position)
ViscousDamping	10	Ns/m	velocity dependent friction at the main valve spool
Mass	0.1	kg	mass of the spool of the main valve
DiameterA	15.5	mm	diameter of the working area of the main valve spool
AaToAx	0.97	-	Area ratio of area A / area X
VolumeFlowControl-Orifice	1	l/min	flow through the control orifice at a *PressureDifferenceControlOrifice*
PressureDifference-ControlOrifice	2.5	bar	see above

Name	Value	Unit	Description
VolumeFlowPositioning-Orifice	1	l/min	flow through the positioning orifice at a *PressureDifferencePositioningOrifice*
PresureDifference-PositioningOrifice	7.5	bar	see above
DeadweightPositioning-Orifice	0.01	l	deadweight volume between positioning orifice and main valve spool
DeadweightPilotPressure	0.01	l	deadweight volume between control orifice and pilot stage spool
VolumeFlowPilot	15	l/min	flow through the pilot stage at *PressureDifferencePilot*
PressureDifferencePilot	200	bar	see above
StrokePilotmax	1	mm	maximum stroke of the pilot valve spool
StrokePilotmin	0	mm	maximum stroke of the pilot stage spool in negative direction
SpringStiffnessPilot	96	N/mm	stiffness of the spring of the pilot stage
SpringPretensioningPilot	4	mm	pretension of the spring of the pilot stage at *StrokePilotmin* (idle position)
ViscousDampingPilot	10	Ns/m	velocity dependent friction of the pilot stage spool
FlowForceCoefficientPilot	0	N/mm/bar	coefficient for the flow forces calculation of the pilot stage
MassPilot	0.02	kg	mass of the pilot valve stage
DiameterPilot	5	mm	diameter of the pilot stage spool
Eoil	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to actual pressure and applied to the pressure equation of the volume between the orifices and the valve spools
TDifference	0	K	Difference between local and system temperature

Notes

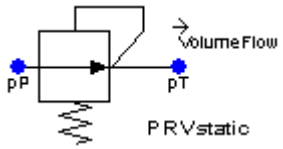
The component PLVPILOTED is a model of a pressure limiting valve where the release of the main spool is achieved by the control of the pilot valve. This way it is possible to switch

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by means of a control pressure from pressure limiting mode to circulation without pressure.

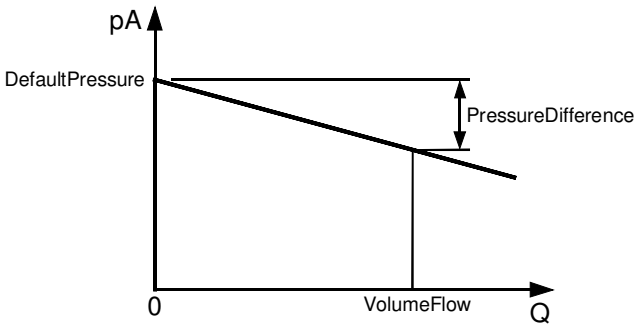
The flow coefficient *AlphaD* varies due to valve geometry between 0.6 and 1.0. For sharp edges it is between 0.60 and 0.64.
The flow angle *Epsilon* describes the angle of the flow over the metering edge. It has considerable influence on the flow forces applied to the main valve spool.

PRVstatic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pA	Hydr	bar	output pressure
VolumeFlow	Out	l/min	flow through the valve

Parameters

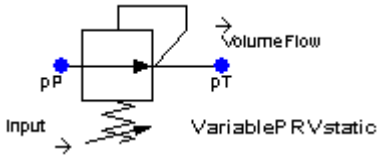
Name	Value	Unit	Description
DefaultPressure	100	bar	set value of the default pressure
VolumeFlow	30	l/min	flow through the valve at a *PressureDifference*
PressureDifference	5	bar	see above

Notes

The component PRVSTATIC is a model of a direct controlled pressure reducing valve, which keeps the output pressure *pA* at different input pressures *pP* at a default pressure. The deviation between output pressure *pA* and the default pressure depends on the flow through the vale and is determined by the parameters *VolumeFlow* and *PressureDifference*.
The component part PRVSTATIC is no model of a pressure reducing valve according to its physical structure. It merely represents the characteristic behavior of a pressure reducing valve. Therefore dynamic effects such as forces due to inertia will not be represented.
In order to chance the default pressure during the simulation choose the adjustable pressure reducing valve (ADJUSTPRVSTATIC). If you want to look at dynamic effects choose the PRVDIRECT.

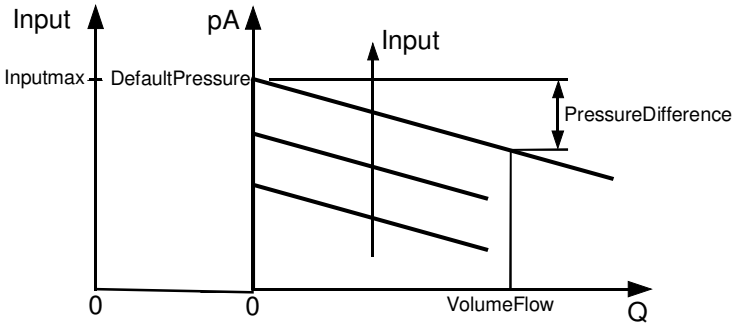
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VariablePRVstatic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	supply pressure
pA	Hydr	bar	controlled pressure
Input	In	-	input signal to adjust the default pressure
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
DefaultPressure	100	bar	default pressure at *InputMax*
PressureDifference	5	bar	pressure difference at *VolumeFlow*
VolumeFlow	30	l/min	see above
InputMax	1	-	maximum input signal. The default pressure will be standardized by this Variable.

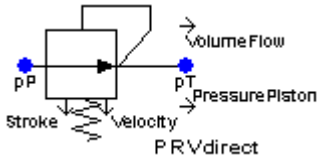
Notes

The VARIABLEPRVSTATIC is a model of a direct controlled pressure reducing valve, which keeps the output pressure *pA* at different input pressures *pP* at a default pressure. The default pressure is determined by the parameters *DefaultPressure* and *Input*. The deviation between output pressure *pA* and the present default pressure depends on the flow

through the vale and is determined by the parameters *VolumeFlow* and *PressureDifference*.
The component part VARIABLEPRVSTATIC is no model of a pressure reducing valve according to its physical structure. It merely represents the characteristic behavior of a pressure reducing valve. Therefore dynamic effects such as forces due to inertia will not be represented.

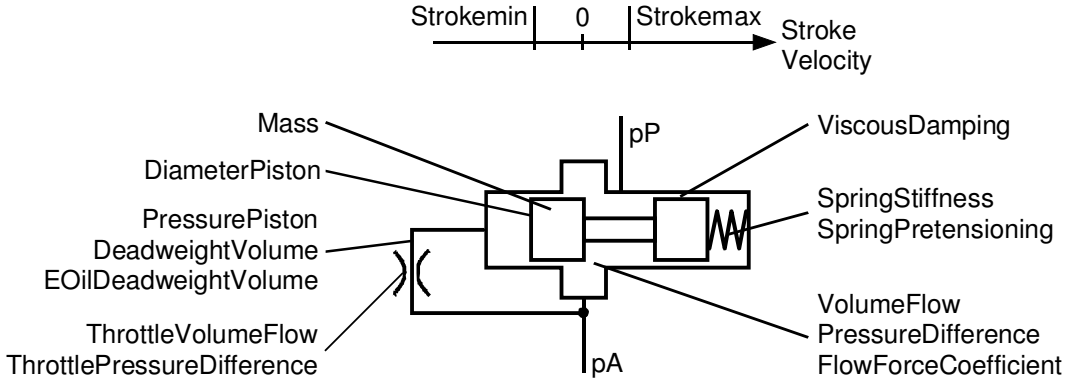
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PRVdirect



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pA	Hydr	bar	output pressure
PressurePiston	Out	bar	pressure behind the throttle (internal auxiliary value which can be displayed for control purposes)
Stroke	Out	mm	stroke of the valve spool (internal auxiliary value which can be displayed for control purposes)
Velocity	Out	m/s	velocity of the valve spool (internal auxiliary value which can be displayed for control purposes)
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference*

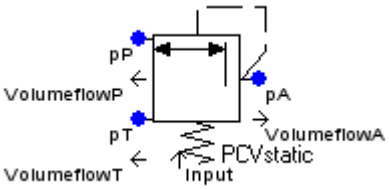
Name	Value	Unit	Description
PressureDifference	5	bar	see above
ThrottleVolumeFlow	5	l/min	flow through the throttle at *ThrottlePressureDifference*
ThrottlePressure-Difference	5	bar	see above
SpringStiffness	60	N/mm	stiffness of the spring
SpringPretensioning	6.5	mm	pre-tension of the spring at *Stroke* = *Strokemin*
FlowForceCoefficient	0	N/mm/bar	coefficient for flow forces calculation
Strokemax	2	mm	maximum spool stroke
Strokemin	0	mm	maximum spool stroke in negative direction
ViscousDamping	10	Ns/m	velocity dependent friction at the spool
Mass	0.4	kg	mass of the valve spool
PistonDiameter	5	mm	diameter of the piston
Deadweight	0.1	l	dead weight volume between throttle spool valve
EoilDeadweight	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to actual pressure and applied to the pressure equation of the dead weight volume.

Notes

The component PRVDIRECT is a model of a direct controlled pressure reducing valve, which keeps the output pressure *pA* at different input pressures *pP* at a default pressure. The default pressure is determined by the parameters *SpringStiffness* and *SpringPretensioning*.

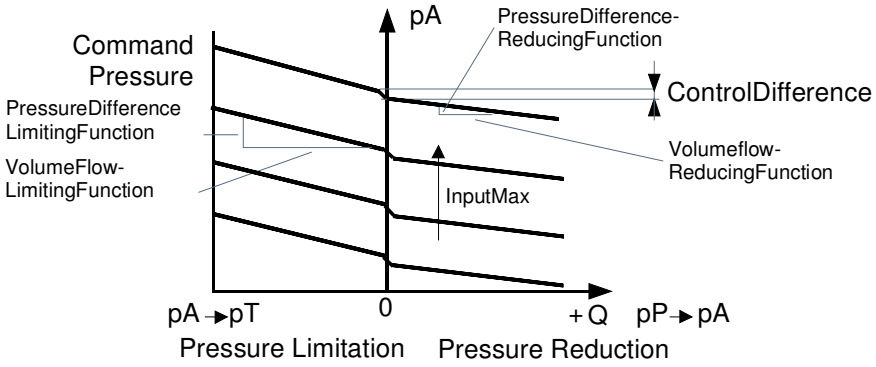
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PCVstatic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pA	Hydr	bar	working pressure
pT	Hydr	bar	tank pressure
VolumeflowP	Out	l/min	flow through the valve in connection pP
VolumeflowA	Out	l/min	flow through the valve in connection pA
VolumeflowT	Out	l/min	flow through the valve in connection pT

Parameters

Name	Value	Unit	Description
CommandPressure	100	bar	target pressure in connections pA
VolumeflowReducingFunction	30	l/min	flow through the throttle at PressureDifferenceReducingFunction

Name	Value	Unit	Description
PressureDifferenceReducingFunction	5	bar	see above
VolumeFlowLimitingFunction	30	l/min	flow through the throttle at PressureDifferenceLimitingFunction
PressureDifferenceLimitingFunction	5	bar	see above
ControlDifference	3	bar	hysteresis
InputMax	1		maximum input signal value

Notes

The component **PCVSTATIC** is a model of a 3- way pressure-reducing valve, which controls a constant output pressure at the working connection port.

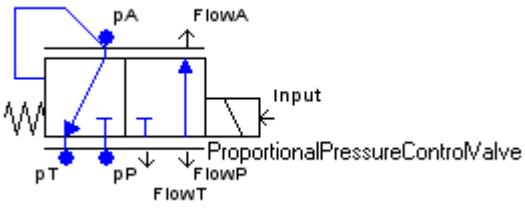
If the pressure increases at pA, a volume flow according to the characteristic line is active, if the pressure increases at pA the volume flow form pP to pA is active.

Only the real pressure is reached, if the pressure at connection pP is smaller than the *CommandPressure*.

The *ControlDiffernce* defines the difference between the start of the pressure reduction control and the start of the pressure limitation control.

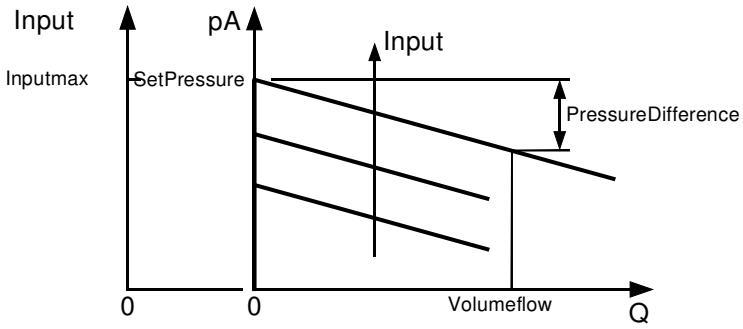
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ProportionalPressureControlValve



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	input pressure
pA	Hydr	bar	output pressure
pT	Hydr	bar	drainPressure
FlowA	Out	l/min	Volume flow at the output A
FlowP	Out	l/min	Volumeflow at the input P
FlowT	Out	l/min	Volumeflow at the drainT
Input	In	-	Input signal for controlling the standard pressure value
Stroke	V	%	Starting value of the valve stroke

Parameters

Name	Value	Unit	Description
VolumeflowPA	5	l/min	Volumeflow through the valve by Pressure difference
PressureDifferencepA	5	bar	Pressure difference causing the volume flow

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Name	Value	Unit	Description
VolumeflowAT	5	l/min	Volume flow through the valve by pressure difference
PressureDifferenceAT	12	bar	Pressure difference causing the volume flow
PressureFlowrateConductancePA	-1	bar/(l/min)	Pressure drop metering edge PA
PressureFlowrateConductanceAT	1	bar/(l/min)	Pressure drop metering edge AT
Overlap	-10	%	Overlap metering edge
InputMax	1		
MinimumInput			
T	30	ms	Time constant at the step answer

Notes

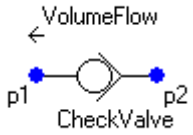
The component PROPORTIONALPRESSURECONTROLVALVE is am model of a 3/2 proportional valve, which controls the pressure at connection pA. It works undependendly from pressure at connection pP.

The PROPORTIONALPRESSURECONTROLVALVE reduces proportional to the Input the pressure in the connection pA. The valve is suitable for use in mobile and vehicle technic area.

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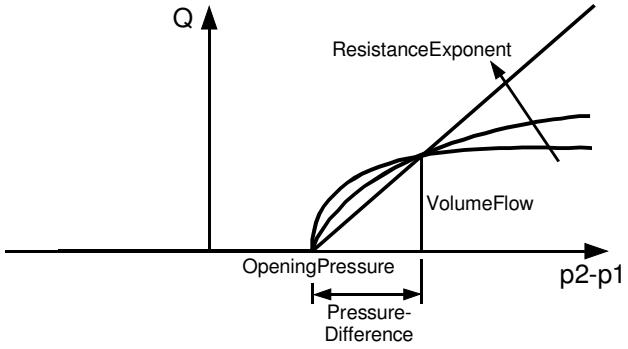
Check Valves

CheckValve



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference* + *OpeningPressure*
PressureDifference	5	bar	see above
OpeningPressure	1	bar	pressure necessary to overcome the locking spring force
ResistanceExponent	1	-	exponent to represent the dependence of the flow from the pressure difference (*p2-p1*)

Notes

The component CHECKVALVE is the model of a check valve which blocks the flow (Q) in the direction from *p1* towards *p2*. In the opposite direction, from *p2* towards *p1*, the valve

behaves similar to a technical resistance. The locking function is thereby represented by a spring. The *OpeningPressure* is the pressure necessary to overcome the locking spring force. The opening condition is *p2 > p1 + OpeningPressure*.

The flow through the valve is characterized by the parameters *VolumeFlow*, *PressureDifference* and *ResistanceExponent*.

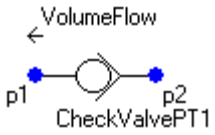
By means of the parameter *ResistanceExponent* it is possible to model a linear or a square root dependency of the flow from a certain pressure difference. Is the *ResistanceExponent* 1 it is a linear dependency is it 0.5 it is a square root dependency. An arbitrary dependency can be modeled by varying the parameter between 1 and 0.5.

The component part CHECKVALVE is no model of a check valve according to its physical structure. It merely represents the characteristic behavior of a check valve. Therefore dynamic effects such as forces due to inertia will not be represented.

There is also a component part available where the locking position can be released by means of a control pressure (PILOTCONROLLEDCHECKVALVE).

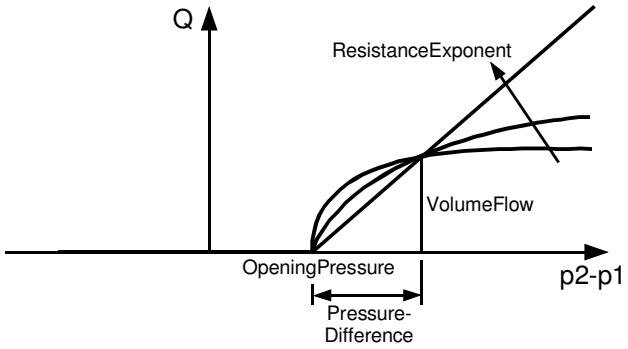
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CheckValvePT1



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
OpeningPressureDifference	V	bar	pressure difference at the metering edge
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference* + *OpeningPressure*
PressureDifference	5	bar	see above
OpeningPressure	1	bar	pressure necessary to overcome the locking spring force
ResistanceExponent	1	-	exponent to represent the dependence of the flow from the pressure difference (*p2-p1*)
T	1	ms	time constant of the mechanical system that is not capable to oscillate

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Notes

The component CHECKVALVEPT1 is the model of a check valve which blocks the flow (Q) in the direction from *p1* towards *p2*. In the opposite direction, from *p2* towards *p1*, the valve behaves similar to a technical resistance. The locking function is thereby represented by a spring. The *OpeningPressure* is the pressure necessary to overcome the locking spring force. The opening condition is *p2 > p1 + OpeningPressure*.

The flow through the valve is characterized by the parameters *VolumeFlow*, *PressureDifference* and *ResistanceExponent*.

By means of the parameter *ResistanceExponent* it is possible to model a linear or a square root dependency of the flow from a certain pressure difference. Is the *ResistanceExponent* 1 it is a linear dependency is it 0.5 it is a square root dependency. An arbitrary dependency can be modeled by varying the parameter between 1 and 0.5.

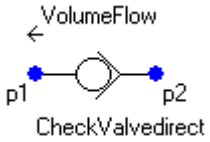
The component part CHECKVALVEPT1 is no model of a check valve according to its physical structure. It merely represents the characteristic behavior of a check valve. The dynamic effects which can occur in real valve such as forces due to inertia will be represented by means of the parameter *T*, which is the time constant of an idealized first order mechanical system that can not oscillate.

A check valve is also available, that represents a second order mechanical system, including bouncing of the bullet in the seat and intern leakage, and that is able to oscillate (CheckValveDynamic).

There is also a component available where the locking position can be released by means of a control pressure (PILOTCONROLLEDCHECKVALVE).

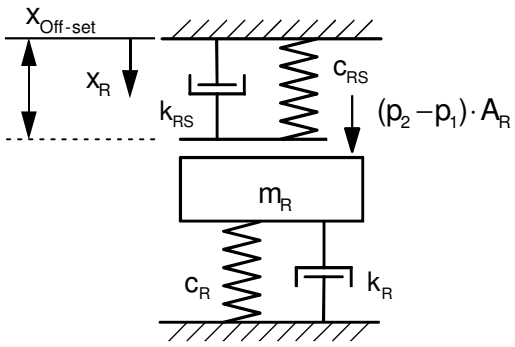
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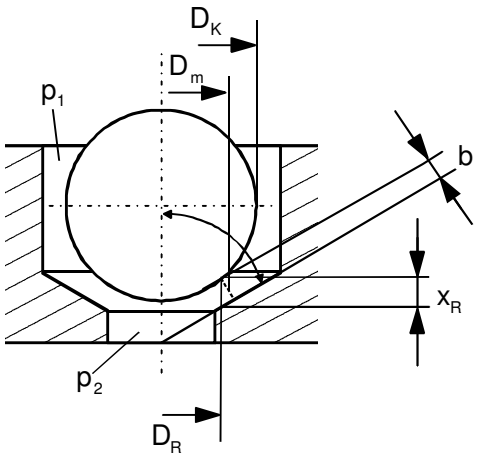
CheckValvedirect



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
Stroke	V	mm	active stroke (X_R) of the bullet
Velocity	V	m/s	velocity of the bullet
VolumeFlow	Out	l/min	flow through the valve

Parameters

Name	Value	Unit	Description
VolumeFlow	10	l/min	flow through the valve at full stroke and pressure difference listed below
PressureDifference	1.	bar	see above
Strokemax	1.	mm	maximal stroke of the valve bullet
Strokemin	0.	mm	minimal stroke of the valve bullet

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Name	Value	Unit	Description
BallDiameter	5.	mm	diameter of the valve bullet (D_K)
BoreDiameter	4.	mm	diameter of the valve inlet bore (D_R)
BallMass	5	g	mass of the valve bulletkugel
ValveSeatAngle	45.	deg	angle of the valve seat (φ_R)
ViscousDamping	1.	Ns/m	viscosity dependent friction of the valve bullet
SpringStiffness	0.5.	N/mm	stiffness of the return spring
SpringPretensioning	1.	mm	pre-tensioning of the spring at *Stroke = Strokemin*
InternalLeakage	0.001	l/min/bar	pressure dependent internal leakage (both directions!)
FlowForceCoefficient	0.	N/mm/bar	coefficient for the flow forces calculation
ImpactDuration	0.1	ms	duration of the impact
ImpactNumber	0.8		Newton's impact coefficient β

Notes

The component CHECKVALVEDIRECT is the model of a check valve according to its physical structure. This means the dynamic effects which can occur in real valve such as forces due to inertia will be represented.

The valve blocks the flow (Q) in the direction from *p1* towards *p2*. In the opposite direction, from *p2* towards *p1*, the valve behaves similar to an orifice. The locking function is thereby represented by a spring. The *OpeningPressure* is the pressure necessary to overcome the locking spring force. It is applied to an opening area that is calculated in dependence of the *ValveSeatAngel* the *BulletDiameter* and the BoreDiameter with the following equation.

$$A_O = \frac{\pi}{4} \cdot (D_K \cdot \cos \varphi_R)^2$$

respectively

$$A_{OR} = \frac{\pi}{4} \cdot (D_R)^2$$

if the cross section of the bore is greater than the cross section defined throught the contact line of ball and valve seat.

The flow characteristic of the valve is calculated due to the orifice equation. It has to be considered that the current flow section changes in dependents on the active valve bullet stroke (X_R) and the valve seat angle (φ_R).

$$A_S = \pi \cdot D_m \cdot b = \pi \cdot (D_K \cdot \cos \varphi_R + x_R \cdot \sin \varphi_R \cdot \cos \varphi_R) \cdot x_R \cdot \sin \varphi_R .$$

Initial position of the valve stroke is always the point of contact between bullet and seat.

If the bullet touches the valve seat - ValveStroke < Strokemin - a force is applied to the bullet according to the following equation

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$$F_{RS} = k_{RS} \cdot \dot{x} + c_{RS} \cdot x_R .$$

The damping and the elasticity can be determined through measurements and can be represented as impact time t_S and Newton's impact coefficient β. If one considers the impact as a half period of a damped periodic oscillation the spring stiffness c_{RS} and the damping constant k_{RS} ofthe valve seat are calculated as follows

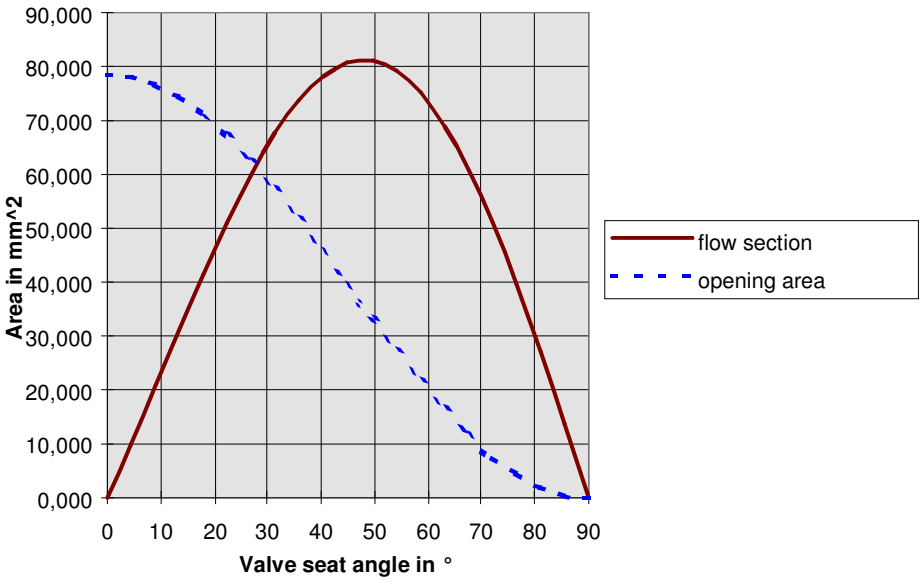
$$c_{RS} = \left(\frac{\pi}{t_S}\right)^2 \cdot m_R$$

and

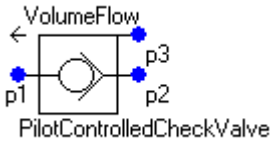
$$k_{RS} = -\frac{2 \cdot m_R}{t_S} \cdot \ln \beta$$

In the present model the mass of the valve bullet is far smaller as the mass of the valve casting, thus the velocity of the valve casting after the impact can be neglected. The Newton's impact coefficient is therefore determined as ration of the valve bullet velocity before and after the impact.

The graphic displays as an example the change of the current flow section and the opening area in dependence on the valve seat angle at a constant bullet diameter of 10 mm and at a constant valve stroke of 4 mm.

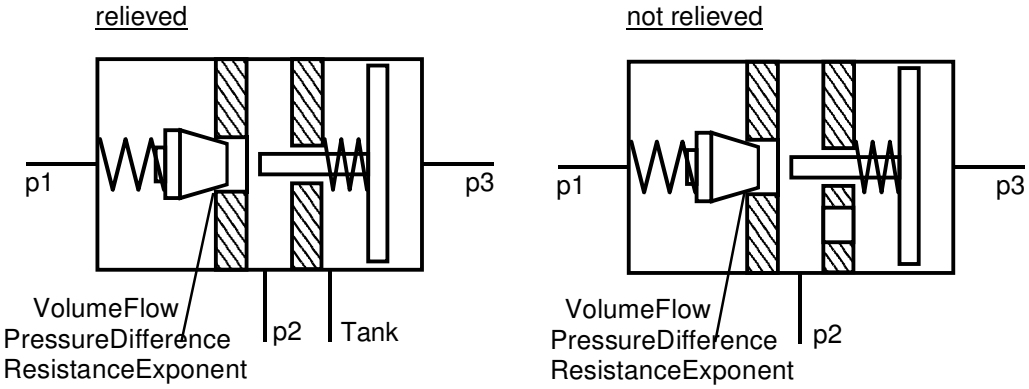


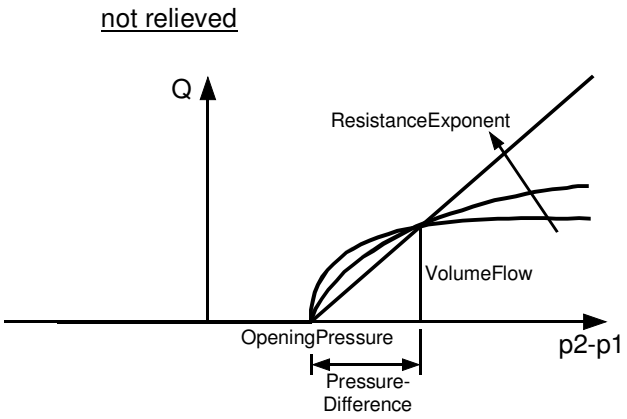
PilotControlledCheckValve



Symbol

Sketch





Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	pressure 1
p2	Hydr	bar	pressure 2
p3	In	bar	control pressure
VolumeFlow	Out	l/min	flow through the valve

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *p2* - *p1* = *PressureDifference* + *OpeningPressure*
PressureDifference	5	bar	see above
OpeningPressure	1	bar	pressure necessary to overcome the locking spring force
ResistanceExponent	1	-	exponent to represent the dependence of the flow from the pressure difference (*p2*-*p1*)
MaintenancePressure	8	bar	pressure necessary to overcome the spring forces
Relieved	0	-	0: No 1: Yes
PressureRatio	3	-	ratio of *p1* to *p3* at stability (corresponds to the ratio of the area applied with *p1* to the area applied with *p3* of a balanced valve)

Notes

The component PILOTCONTROLLEDCHECKVALVE is the model of a check valve which blocks the flow (Q) in the direction from *p1* towards *p2*. In the opposite direction, from *p2* towards *p1*, the valve behaves similar to a technical resistance. The locking function is thereby represented by a spring. The *OpeningPressure* is the pressure necessary to overcome the locking spring force. The opening condition is p2 > p1 + OpeningPressure.

The flow through the valve is characterized by the parameters VolumeFlow, PressureDifference and ResistanceExponent.

If the valve is unlocked by means of the control pressure *p3* the valve behaves like a technical resistor in both directions. The unlocking condition for a relieved valve (*Relieved* = 1) is

$$p3 > \frac{p1 - p2}{PressureRatio} + MaintenancePressure$$

and for a unrelieved valve (*Relieved* = 0)

$$p3 > \frac{p1 - p2}{PressurRatio} + MaintenancePressure + p2\,.$$

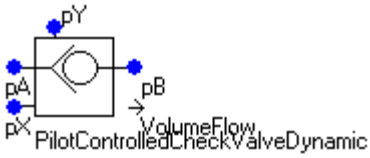
Since it is not necessary to connect the reservoir outlet required to relieve the valve this outlet is not part of the model.
By means of the parameter *ResistanceExponent* it is possible to model a linear or a square root dependency of the flow from a certain pressure difference. Is the *ResistanceExponent* 1 it is a linear dependency is it 0.5 it is a square root dependency. An arbitrary dependency can be modeled by varying the parameter between 1 and 0.5.

The component part PILOTCONTROLLEDCHECKVALVE is no model of a check valve according to its physical structure. It merely represents the characteristic behavior of a check valve. Therefore dynamic effects such as forces due to inertia will not be represented.

There is also a component available where the locking position can be released by means of a control pressure that is modeled according to its physical structure (PILOTCONROLLEDCHECKVALVEDYNAMIC).

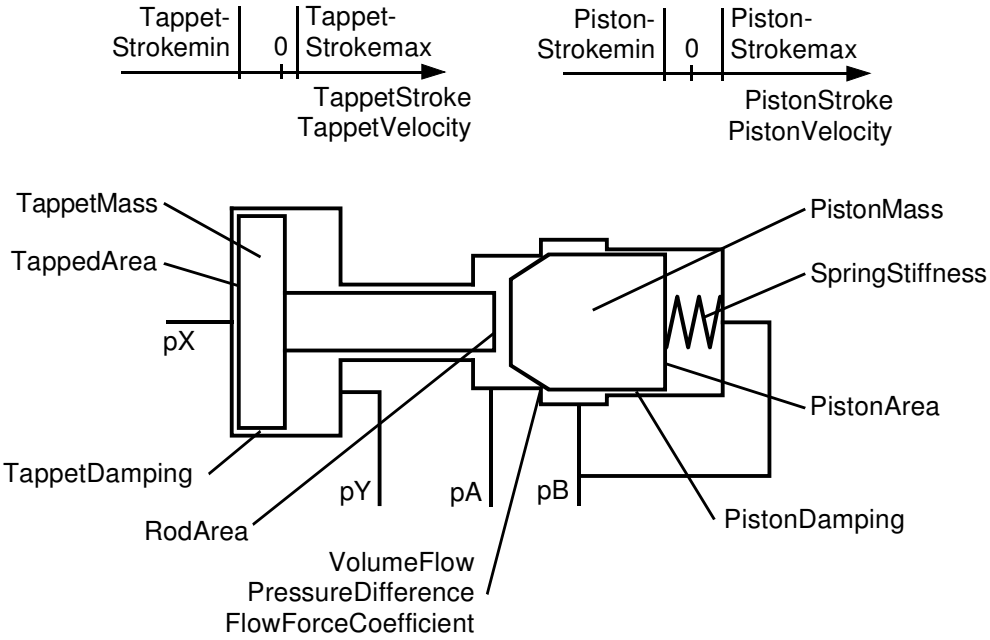
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PilotControlledCheckValveDynamic



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	pressure at connector A
pB	Hydr	bar	pressure at connector B
pX	Hydr	bar	control pressure
pY	Hydr	bar	pressure at the leakage outlet
TappetStroke	Out	mm	tappet stroke
TappetVelocity	Out	m/s	tappet velocity
PistonStroke	Out	mm	piston stroke
PistonVelocity	Out	m/s	piston velocity
VolumeFlow	Out	l/min	flow through connector B

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Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *PressureDifference* and maximum opening aperture
PressureDifference	5	bar	s.o.
OpeningPressure	1	bar	pressure necessary to overcome the spring forces
TappetArea	3	cm^2	active area of the tappet
PistonArea	1.3	cm^2	active area of the piston
RodArea	0.8	cm^2	active area of the rod
TappetMass	0.1	kg	mass of the tapped
PistonMass	0.1	kg	mass of the piston
TappetStrokemax	5	mm	maximum tapped stroke
TappetStrokemin	0	mm	maximum tapped stroke in negative direction
PistonStrokemax	5	mm	maximum piston stroke
PistonStrokemin	0	mm	maximum piston stroke in negative direction
TappetDamping	10	Ns/m	velocity dependent friction at the tappet
PistonDamping	10	Ns/m	velocity dependent friction at the piston
SpringStiffness	2	N/mm	stiffness of the closing spring
FlowForceCoefficient	0	N/mm/bar	coefficient for the flow forces calculation

Notes

The component PILOTCONTROLLEDCHECKVALVEDYNAMIC is the model of a check valve according to its physical structure. This means dynamic effects thus as forces due to inertia will be considered.

The valve blocks the flow (Q) in the direction from *pB* towards *pA*. In the opposite direction, from *pA* towards *pB*, the valve behaves similar to an orifice resistance. The locking function is thereby represented by a spring. The *OpeningPressure* is the pressure necessary to overcome the locking spring force.

The flow through the valve is characterized by the parameters *VolumeFlow*, *PressureDifference* and *ResistanceExponent*.

If the valve is unlocked by means of the control pressure *pX* the valve behaves like a technical resistor in both directions.

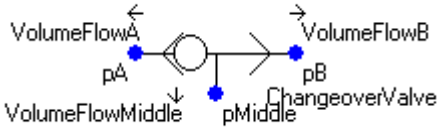
Are tappet and piston at their limits at *Tappetstrokemin* and *Pistonstrikemin* there is usually a gap between both of them. This gap can be taken into consideration if the stroke limitations are parameterized according to the following equations:

Tappetstrokemax = Pistonstrokemax -gap,
Tappetstrokemin = Pistonstrokemin - gap.

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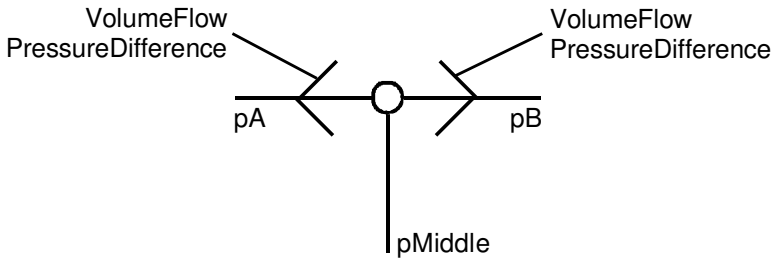
There is also a component available (PILOTCONTROLLEDCHECKVALVE) which is not modeled according to its physical structure. It merely represents the characteristic behavior of a check valve. Therefore dynamic effects such as forces due to inertia will not be represented.

ChangeoverValve



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pA	Hydr	bar	working pressure A
pB	Hydr	bar	working pressure B
pMiddle	Hydr	bar	supply pressure
VolumeFlowA	Out	l/min	flow through outlet A
VolumeFlowB	Out	l/min	flow through outlet B
VolumeFlowMiddle	Out	l/min	supply flow

Parameters

Name	Value	Unit	Description
VolumeFlow	30	l/min	flow through the valve at *Pressure-Difference* (*pMiddle - pA resp. Pmiddle - pB*)
PressureDifference	5	bar	see above

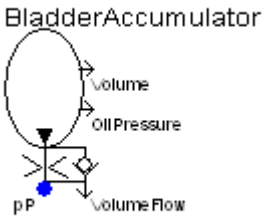
Notes

The component CHANGEOVERVALVE is the model of a valve where the working outlet *pMiddle* is connected with the inlet that has the higher pressure level (*pA* or *pB*).

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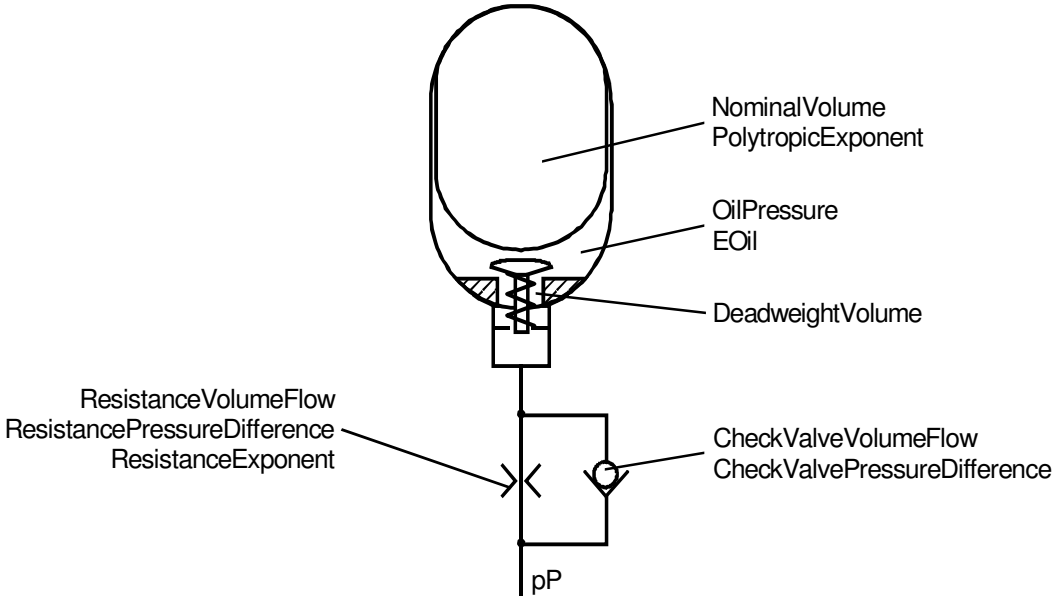
Accumulators

BladderAccumulator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	accumulator connector
OilPressure	Out	bar	hydraulic fluid pressure within accumulator
VolumeFlow	Out	l/min	flow emerging from *pP*
Volume	Out	l	actual hydraulic volume

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Parameters

Name	Value	Unit	Description
ResistanceVolumeFlow	30	l/min	flow through the resistance at *ResistancePressure-Difference*
ResistancePressure-Difference	5	bar	see above
ResistanceExponent	1	-	exponent, that describes the flow in dependence on the applied pressure difference *Oil-Pressure - pP*
CheckValveVolumeFlow	30	l/min	flow through the check valve at *CheckValvePressure-Difference*
CheckValvePressure-Difference	5	bar	see above
PolytropicExponent	1.4	-	exponent which describes the dependence of pressure and volume change of the pressure gas
PretensioningPressure	50	bar	gas pressure in the accumulator in the not connected state
NominalVolume	5	l	maximum volume of the gas bubble
DeadweightVolume	0.1	l	liquid volume residual in the accumulator at maximum size of the gas bubble
Eoil	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure in the accumulator

Notes

The component *BladderAccumulator* constitutes a model of a gas accumulator with which the pressure gas is included in a rubber bladder.

The parameter *PretensioningPressure*, *NominalVolume*, and *DeadweightVolume* describe the accumulator in the not connected state. At the beginning of a simulation run the state variables of the accumulator are computed depending on that for *OilPressure* chosen start value.

If the gas bubble has achieved its maximum volume, only the *DeadweightVolume* remains in the accumulator. Therefore at small dead volume a high mathematical stiffness of the accumulator can result, what possibly requires a correspondingly small simulation increment.

With the parameter *ResistanceExponent* hybrid forms between linear and root shaped dependence of the pressure difference *pP - OilPressure* declining at the connection resis-

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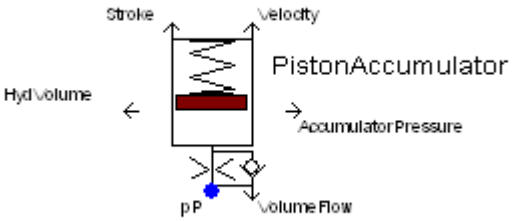
tance and the flow can be described. For linear dependence, the resistance exponent is controlled by 1, for root shaped dependence in the case of 0,5.

The poly tropics exponent describes the dependence of pressure and volume change of the pressure gas. State change is isothermic for poly tropics exponent = 1. A complete interchange of heat occurs with the environment so that no temperature change occurs. This way of state change is to be encountered in hydraulic accumulators if the loading or unloading cycle of the printing liquid occurs via a long period. At a poly tropics exponent of 1.4 an adiabatic state change takes place with which no heat exchange with the environment can occur.

Through the parameter *Eoil* the different wale thickness of the accumulator compared to the pipes employed in the system can be considered .

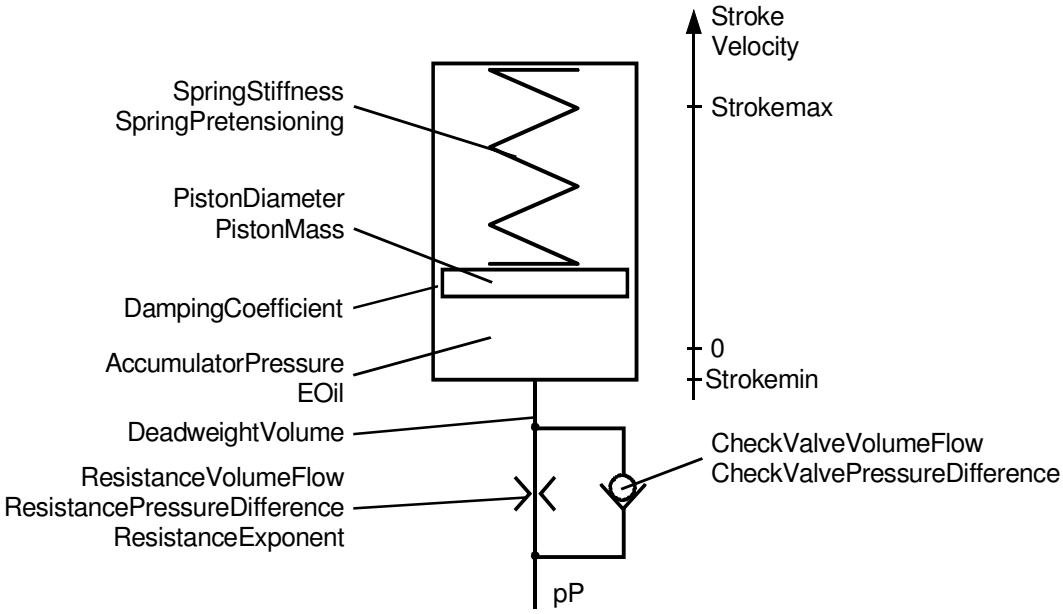
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PistonAccumulator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	accumulator connector
AccumulatorPressure	Out	bar	pressure within accumulator
Stroke	Out	mm	stroke of the piston
Velocity	Out	m/s	piston velocity
VolumeFlow	Out	l/min	flow emerging from *pP*
HydVolume	Out	l	actual hydraulic volume

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Parameters

Name	Value	Unit	Description
ResistanceVolumeFlow	30	l/min	flow through the resistance at *ResistancePressure-Difference*
ResistancePressure-Difference	5	bar	see above
ResistanceExponent	1	-	exponent, that describes the flow in dependence on the applied pressure difference *Oil-Pressure - pP*
CheckValveVolumeFlow	30	l/min	flow through the check valve at *CheckValve-PressureDifference*
CheckValvePressure-Difference	5	bar	see above
DeadweightVolume	0.1	l	fluid volume residual in the accumulator at Stroke = Stroke-min
SpringStiffness	10	N/mm	stiffness of the piston spring
SpringPretensioning	20	mm	pretension of the piston spring at *Stroke* = *Strokemin*
PistonDiameter	100	mm	diameter of the piston
PistonMass	1	kg	mass of the piston
DampingCoefficient	10	Ns/m	velocity depended friktion at the piston
Strokemax	100	mm	maximum piston stroke
Strokemin	0	mm	maximum piston stroke in negative direction
Eoil	14000	bar	bulk modulus of the hydraulic liquid including the wall at high pressure in the accumulator

Notes

The component *PistonAccumulator* constitutes a model of a hydraulic accumulator with which a feather is used for compressive load.

If the piston has achieved its minimum stroke (*Stroke* = *Strokemin*), only the *DeadweightVolume* remains in the accumulator. Therefore at small dead volume a high mathematical stiffness of the accumulator can result, what possibly requires a correspondingly small simulation increment.

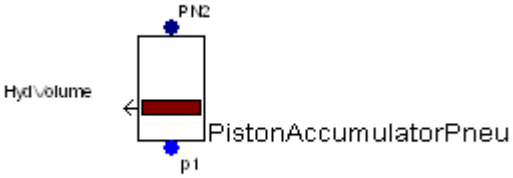
With the parameter *ResistanceExponent* hybrid forms between linear and root shaped dependence of the pressure difference *pP* - *OilPressure* declining at the connection resistance and the flow can be described. For linear dependence, the resistance exponent is controlled by 1, for root shaped dependence in the case of 0,5.

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Through the parameter *Eoil* the different wale thickness of the accumulator compared to the pipes employed in the system can be considered .

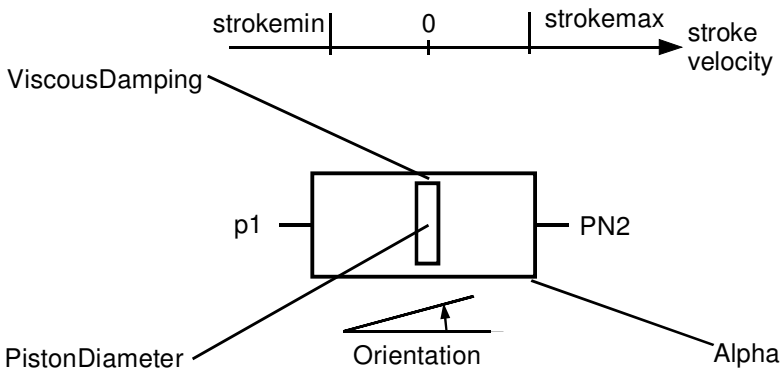
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PistonAccumulatorPneu



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hydr	bar	hydraulic accumulator connector
PN2	Pneu	bar	pneumatic accumulator connec-tor tor
stroke	V	mm	Stroke of the piston
velocity	V	m/s	Velocity of the piston
HydVolume	Out	l	actual hydraulic volume

Parameters

Name	Value	Unit	Description
Diameter	100	mm	Diameter of the piston
strokemax	100	mm	maximum piston stroke
strokemin	0	mm	maximum piston stroke in nega-tive direction
PistonMass	1	kg	Mass of the piston
ViscousDamping	10	Ns/m	characteristic for Stribeck curve

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Name	Value	Unit	Description
Orientation	0	deg	Angle between the movement plane and the horizontal plane
Alpha	75	W/m²/K	Heat transfer coefficient
Tdiffernce	0	K	Temperature difference between local temperature and global system temperature

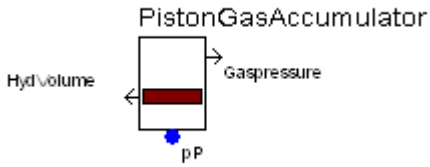
Notes

The component **PISTONACCUMULATOPNEU** constitutes a model of a hydraulic accumulator with which the oil and the gas are separated by a piston.

The heat transfer on the pneumatic side of the cylinder is considered with coefficient α.

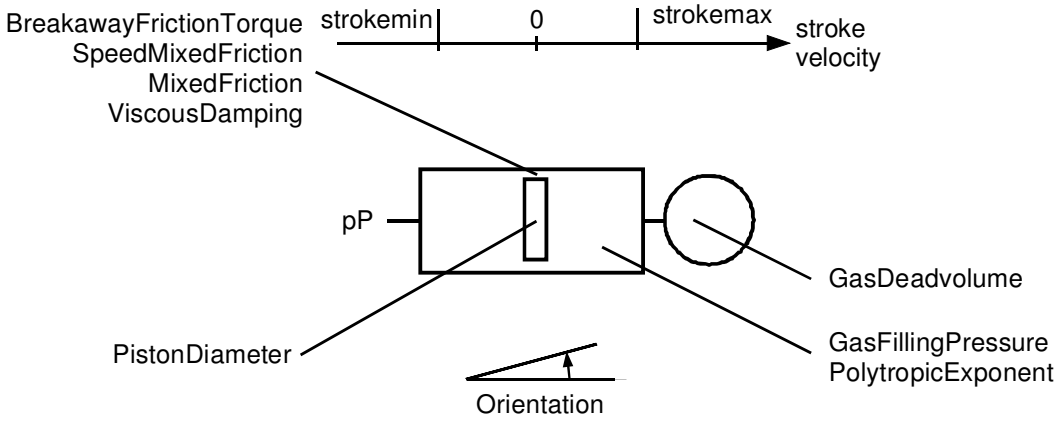
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PistonGasAccumulator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accumulator connector
Gaspressure	Out	bar	Pressure of gas in the accumulator
stroke	V	mm	Stroke of the piston
velocity	V	m/s	Velocity of the piston
Volumeflow	Out	i/min	flow emerging from *pP*
HydVolume	Out	l	actual hydraulic volume

Parameters

Name	Value	Unit	Description
PistonDiameter	100	mm	Diameter of the piston
strokemax	100	mm	maximum piston stroke
strokemin	0	mm	maximum piston stroke in negative direction

Name	Value	Unit	Description
PolytropicExponent	1.4	-	Exponent which describes the dependence of pressure and volume change of the pressure gas
GasFillingPressure	20	bar	Gas pressure in the accumulator in the not connected state
GasDeadVolume	0.1	l	Gas volume that cannot be compressed (e. g. gas bottle)
Mass	1	kg	Mass of the piston
BreakawayFrictionForce	100	N	characteristic for Stribeck curve
MixedFrictionForce	10	N	characteristic for Stribeck curve
SpeedMixedFriction	0.1	m/s	characteristic for Stribeck curve
ViscousDamping	10	Ns/m	characteristic for Stribeck curve
Orientation	0	deg	Angle between the movement plane and the horizontal plane

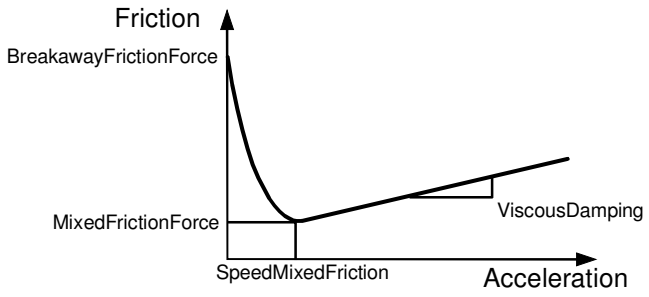
Notes

The component *PistonGasAccumulator* constitutes a model of a hydraulic accumulator with which the oil and the gas are separated by a piston.

If the piston has achieved its maximum stroke (*Stroke* = *Strokemax*), the total gas volume is compressed in the *GasDeadVolume*. Therefore at a small dead volume a high mathematical stiffness of the accumulator can result, what possibly requires a correspondingly small simulation increment.

The *PolytropicExponent* describes the dependence of pressure and volume change of the pressure gas. State change is isothermic for poly tropics exponent = 1. A complete interchange of heat occurs with the environment so that no temperature change occurs. This way of state change is to be encountered in hydraulic accumulators if the loading or unloading cycle of the printing liquid occurs via a long period. At a poly tropics exponent of 1.4 an adiabatic state change takes place with which no heat exchange with the environment can occur.

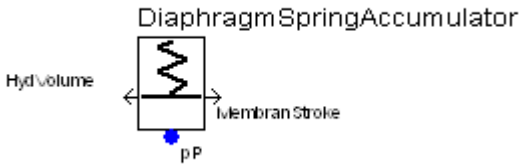
The friction force is computed in accordance to the Stribeck curve. The parameters *BreakawayFrictionForce*, *MixedFrictionForce*, *SpeedMixedFriction*, and the *ViscousDamping* represents the characteristic values shown in the figure. The friction is not influenced by the inclination of the movement plane and it is independent on the pressure.



With the *Orientation*, the movement plane can be sloped in any angle to the horizontal. The resulting force due to gravity is considered automatically.

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DiaphragmSpringAccumulator



Symbol

Sketch

Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accumulator connector
MembranStroke	Mech	N	Stroke of the Membrane
HydVolume	Out	l	actual hydraulic volume

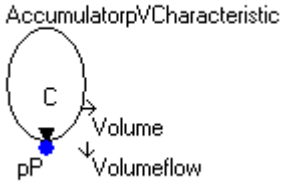
Parameters

Name	Value	Unit	Description
DiaphragmDiameter	50	mm	Diameter of the diaphragm
Springstiffness	1	N/mm	stiffness of the diaphragm spring
Pretensioning	0	mm	pretension of the diaphragm spring
Stroke	5	mm	Stroke of the diaphragm
T	0.5	ms	Time permanence of the diaphragm

Notes

The component DiaphragmSpringAccumulator is a component of a spring accumulator, its separation between oil and gas is massless. To calculate the conduction the movement of the media separation is determined through a PT1-function which is named by parameter time permanence *T*.

AccumulatorpVCharacteristic



Symbol

Sketch

Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accumulator connector
HydrVolume	V	l	Actual hydraulic volume
Volume	Out	l	Actual hydraulic volume
Volumeflow	Out	l/min	flow emerging from *pP*

Parameters

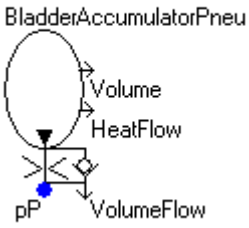
Name	Value	Unit	Description
pVCharacteristic	-1	-	Characteristic with pressureable volume values
T	0.5	ms	Time Permanence of the accumulator

Notes

The component AccumulatorpVCharacteristic is mapping the correlation between pressure and volume of the accumulator throughout the characteristic *pvCharacteristic.* The change of the accumulator volume is directly proportional to pressure, there is no delay. The model specifically is suitable for small accumulators which are used for pulsation damping. Through the characteristic a technical measured conduction is brought in.

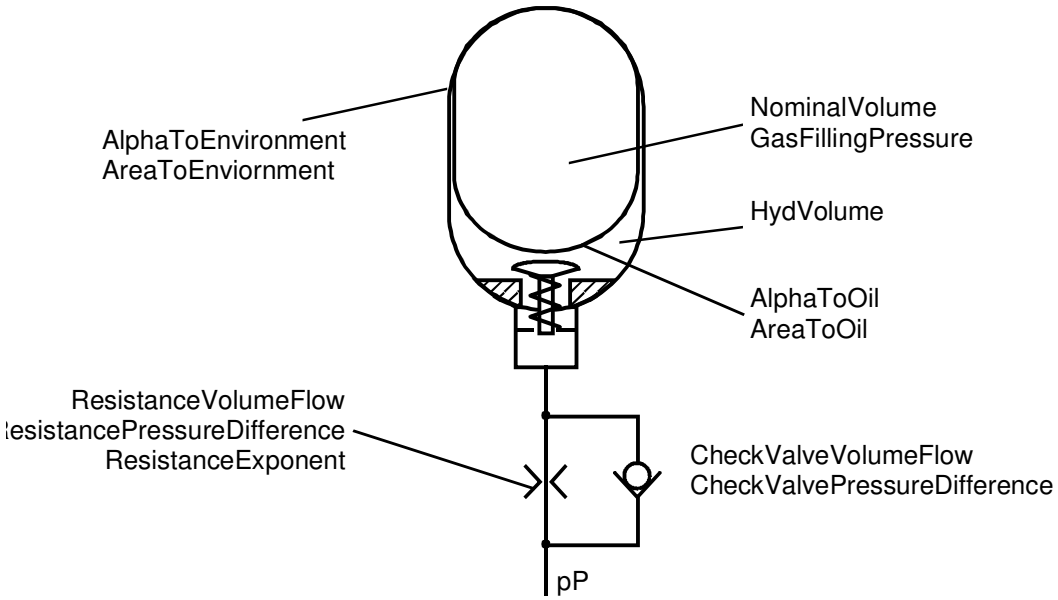
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BladderAccumulatorPneu



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
pP	Hydr	bar	Accumulator connector
GasPressure	V	bar	Pressure of the piston bladder
GasTemperature	V	K	Temperature of the piston bladder
HydVolume	V	L	Actual hydraulic volume
Volume	Out	L	Actual hydraulic volume
VolumeFlow	Out	I/min	flow emerging from *pP*
Heatflow	Out	-	Heatflow flowing between bladder accumulator and environment

Parameters

Name	Value	Unit	Description
NominalVolume	5	l	maximum volume of the gas bubble
AlphaToEnvironment	75.	W/(m^2*K)	heat transfer number from the accumulator to the environment
AreaToEnvironment	100	cm^2	area to calculate the heat transfer
AlphaToOil	75	W/(m^2*K)	heat transfer number between liquid and gas bladder
AreaToOi	100	cm^2	area to calculate the heat transfer
ResistanceExponent	1.	bar -	exponent, that describes the flow in dependence on the applied pressure difference
ResistanceVolumeFlow	30	l/min	flow through the resistance at *ResistancePressureDifference*
ResistancePressureDifference	5	bar	see above
CheckvalveVolumeFlow	30	l/min	flow through the check valve at *CheckValvePressureDifference*
CheckvalvePressureDifference	5	bar	see above
PreChargePressure	50	bar	gas pressure in the accumulator in disconnected state
WithPressureVolumeAdjustment	1	-	0 = No 1 = Yes
TDifference	0	K	Difference between local and system temperature

Notes

The component BladderAccumulatorPneu is a model of a gas pressure accumulator, the pressure gas is perceived through a gum bladder. A heat transfer to the environment is considered too.

The parameter *PreChargePressure, NominalVolume* and *DeadVolume* describes the accumulator in disconnected state. In the beginning of one simulation process the state magnitudes of the accumulator are calculated in dependence to the start value of the oil pressure.

Is the bladder in maximum volume only the *DeadVolume* is left in the accumulator. At minor *DeadVolume* a high mathematical stiffness of the accumulator possibly arises, maybe an accordingly small simulation step size is required.

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The parameter *ResistanceExponent* describes hybrid forms between linear and root shaped dependence of the pressure difference *p1 - p2* on the connector resistance and the flow. For linear dependence, the *ResistanceExponent* is controlled by 1, for root shaped dependence in the case of 0,5.

With the parameter *Eoil* the different wall stiffness of the accumulator towards the used pipes in the system has to be considered.

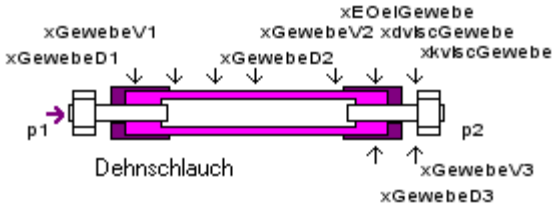
Pipes & Reservoirs

Automotive Lines



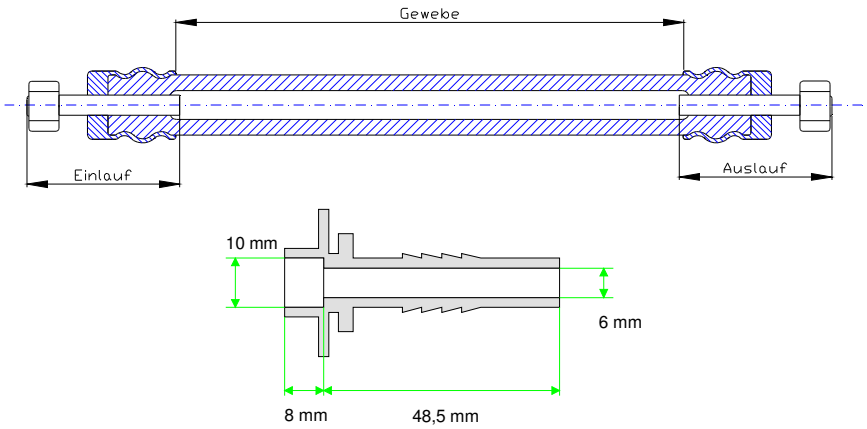
The Automotive Lines components are not finished in th english version yet, but we work hard on it!

Dehnschlauch



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Druck am Rohrende 1

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p2	Hvol	bar	Druck am Rohrende 2
xEOelGewebe	Ein	bar	externer Kompressionsmodul des Öls im Schlauchstück
xdviscGewebe	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Schlauchs
xkviscGewebe	Ein	bar/m	externer viskoelastischer Anteil der Schlauchsteifigkeit
xGewebeV1	Ein	mm/bar	externer Verstärkungsfaktor der ersten Ordnung der nichtlinearen Dämpfung des Schlauchs
xGewebeD1	Ein	-	externer Dämpfungsfaktor der ersten Ordnung der nichtlinearen Dämpfung des Schlauchs
xGewebeV2	Ein	mm/bar	externer Verstärkungsfaktor der zweiten Ordnung der nichtlinearen Dämpfung des Schlauchs
xGewebeD2	Ein	-	externer Dämpfungsfaktor der zweiten Ordnung der nichtlinearen Dämpfung des Schlauchs
xGewebeV3	Ein	mm/bar	externer Verstärkungsfaktor der dritten Ordnung der nichtlinearen Dämpfung des Schlauchs
xGewebeD3	Ein	-	externer Dämpfungsfaktor der dritten Ordnung der nichtlinearen Dämpfung des Schlauchs

Parameters

Name	Value/Unit		Description
LaengeEinlauf	48,5	mm	Gesamtlänge des Einlauf
LaengeGewebe	300	mm	Gesamtlänge des Gewebe
LaengeAuslauf	48,5	mm	Gesamtlänge des Auslauf
DurchmesserEinlauf	6	mm	Innendurchmesser des Einlaufstücks
DurchmesserGewebe	10	mm	Innendurchmesser des Gewebes
DurchmesserAuslauf	6	mm	Innendurchmesser des Auslaufstücks
EOelGewebe	1200	bar	Kompressionsmodul des Öls im Schlauchstück
TDifferenz	0.	K	Abweichung der lokalen Temperatur von der globalen Systemtemperatur

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Name	Value/Unit		Description
Schrittweitenuebersetzung	1	<0=Untersetzung	Verhältnis der Rohrschrittweite zur Simulationsschrittweite -10 == 10 Zwischenschritte pro Simulationsschritt 10 == Aktualisierung alle 10 Simulationsschritte
Qmax	100	l/min	Maximaler Volumenstrom im Leitungselement
ReibungsAnsatz	5	-	Art der Reibungsbeschreibung 0 = frequenzabhängige Reibung aus 1 = Trikha optimiert nach Theissen 2 = Taylor 3 = Trikha erweitert nach Stoffel 4 = Kitagawa 5 = frequenzabh. Reibung nach Müller
epsilonSteigung	1000	-	Faktor bei der Interpolation der Steigung der Charakteristiken
kvisc	1e7	bar/m	viskoelastischer Anteil der Schlauchsteifigkeit
dvisc	3e3	bars/m	Viskoelastischer Dämpfungskoeffizient des
Frequenz	0	Hz	Eigenfrequenz der nichtlinearen Dämpfung des Schlauchs
Exponent	-,9242	-	Exponent der Geweberesonanzgleichung bei t = 40°C
Basiswert	242,23	-	Basiswert der Geweberesonanzgleichung bei t = 40°C
FrequenzfaktorOrd1	1	-	Frequenzfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd1	0,105	-	Dämpfungsfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd1	0,0004	mm/bar	Verstärkungsfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs

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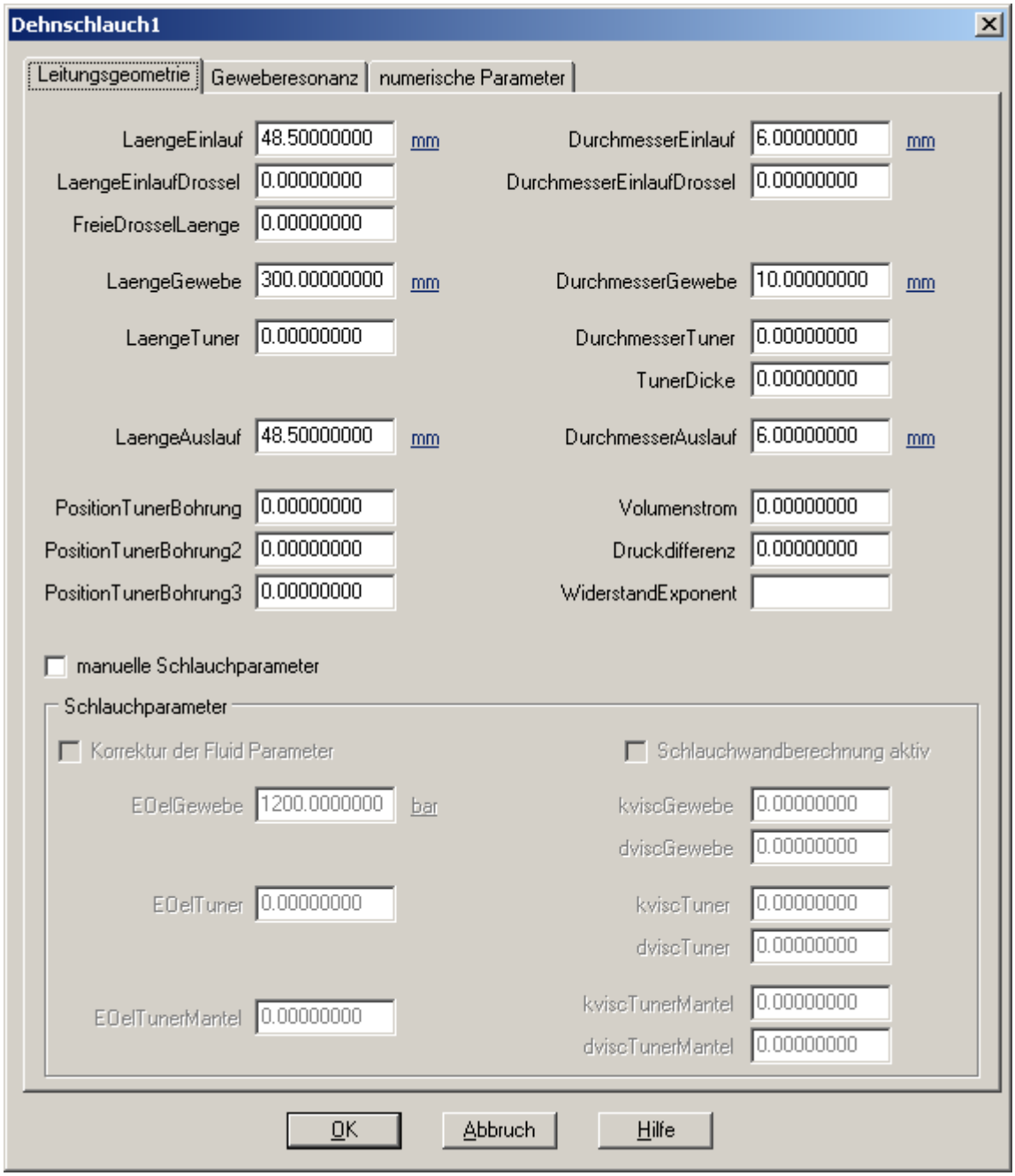
Name	Value/Unit		Description
FrequenzfaktorOrd2	1,8	-	Frequenzfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd2	0,11	-	Dämpfungsfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd2	0,0002	mm/bar	Verstärkungsfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
FrequenzfaktorOrd3	2,6	-	Frequenzfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd3	0,12	-	Dämpfungsfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd3	9e-5	mm/bar	Verstärkungsfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs

Bemerkungen

Das Bauteil DEHNSCHLAUCH ist die Zusammenfassung mehrer verteiltparametrischen Leitungselemente mit dem Ziel, das dynamische Übertragungsverhalten eines Dehnschlauches abzubilden.

Das Bauteil setzt sich aus je einem Einlauf und einem Auslaufstück, die als verteiltparametrische Stahlleitung abgebildet sind, und einem Schlauchleitungselement, das die dynamischen Eigenschaften der Schlauchwand berücksichtigt, zusammen.

Die Parametrierung erfolgt über einen speziellen Leitungsparameterdialog, der drei Reiter für die Eingabe der Leitungsgeometrie, der Parameter der Geweberesonanzen und der numerischen Parameter enthält.



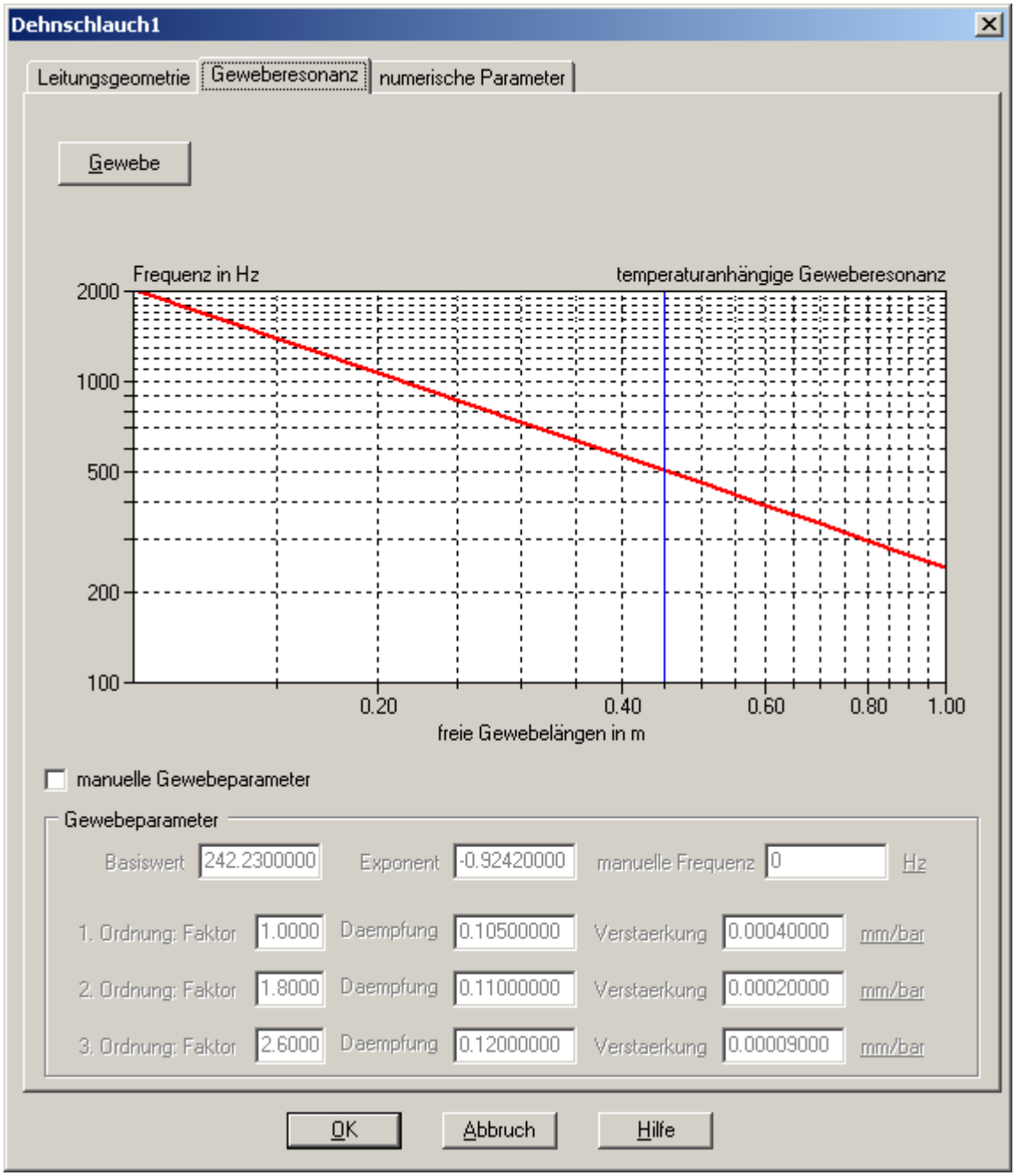
Im Reiter **Leitungsgeometrie** erfolgt im oberen Teil die Eingabe der Geometriedaten für Längen und Durchmesser. Die Einheiten können im allen Teilen des Dialoges geändert werden. Dazu auf die aktuelle Einheit klicken (ist immer unterstrichen) und in der dann sich öffnenden Liste eine neue wählen.

Im unteren Teil wird der zur Berechnung der Wellenausbreitungsgeschwindigkeit benötigte E-Modul, und die Koeffizienten der Wandelastizität eingegeben, falls der Schalter **MANUELLE SCHLAUCHPARAMETER**, Korrektur der **FLUID PARAMETER** und **SCHLAUCHBERECHNUNG** aktiv sind.

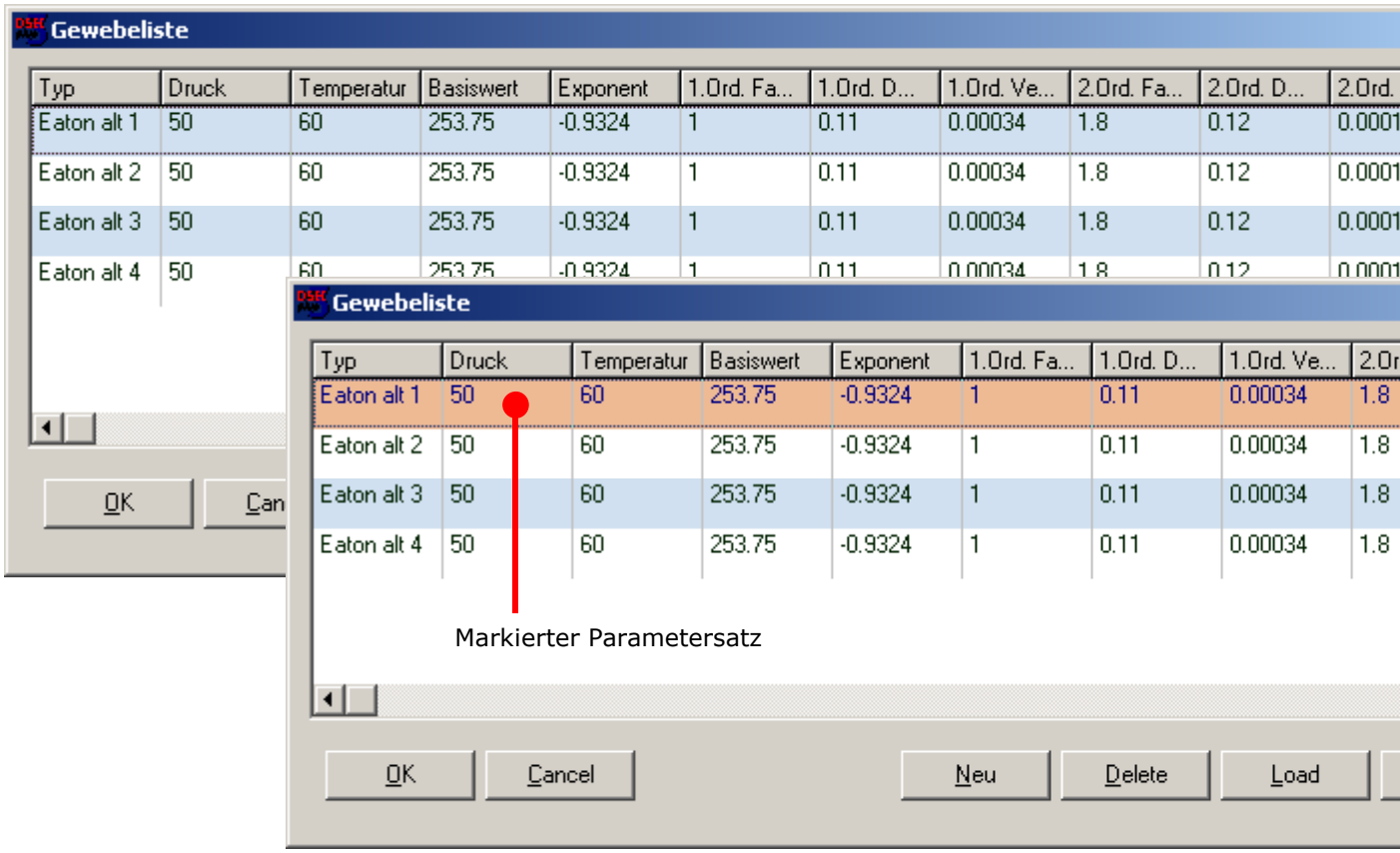
Bei manueller Eingabe werden geladene Daten (siehe **Geweberesonanz**) nicht berücksichtigt.

Gewebeparameter werden im mittleren Reiter **Geweberesonanz** manuell eingetragen, bzw. aus einer *XML*-Datei geladen. Auch hier gilt: Bei manueller Eingabe werden die geladenen Daten nicht berücksichtigt.

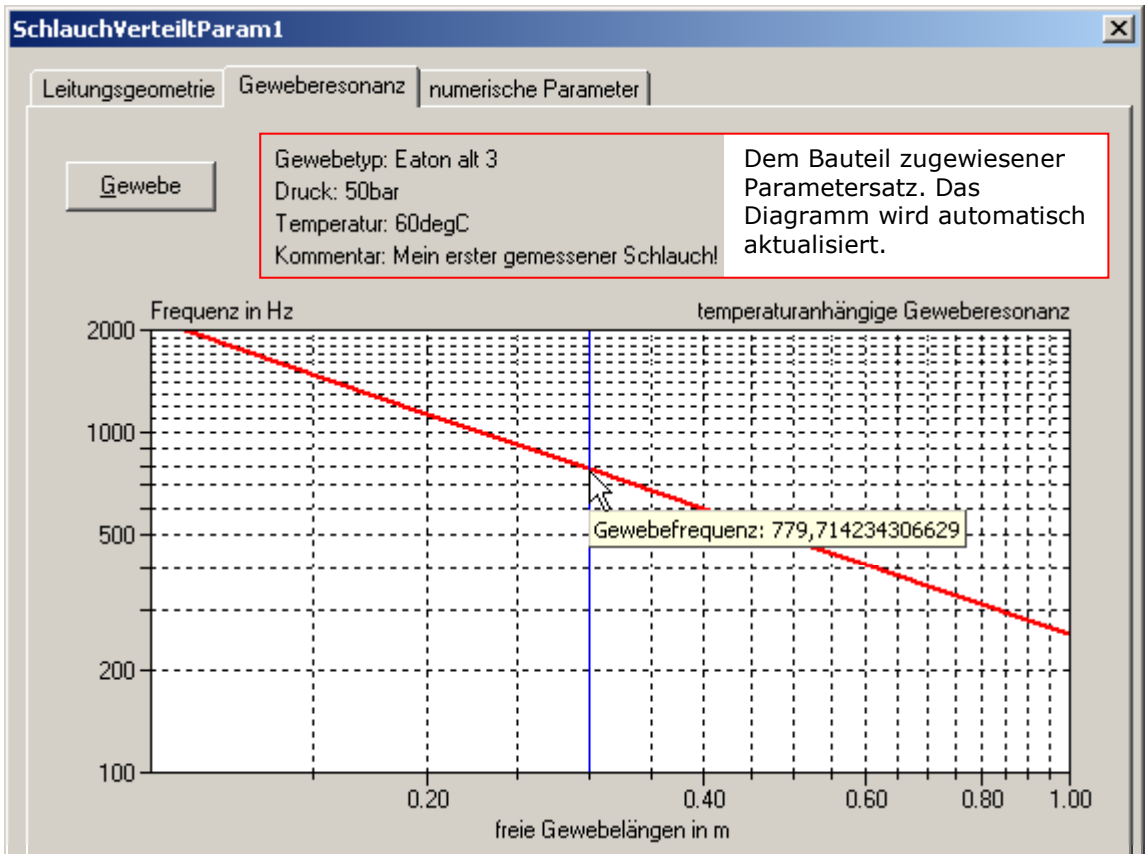
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Die Taste **GEWEBE** öffnet den Dialog **Gewebeliste**, in dem Parametersätze (zeilenweise) zu erkennen sind. Diese Daten sind der *Dehnschlauch.xml* entnommen.



Durch Doppelklick oder Markieren eines Parametersatzes und anschließendem Bestätigen mit **OK** werden die Parameter dem Bauteil zugewiesen.

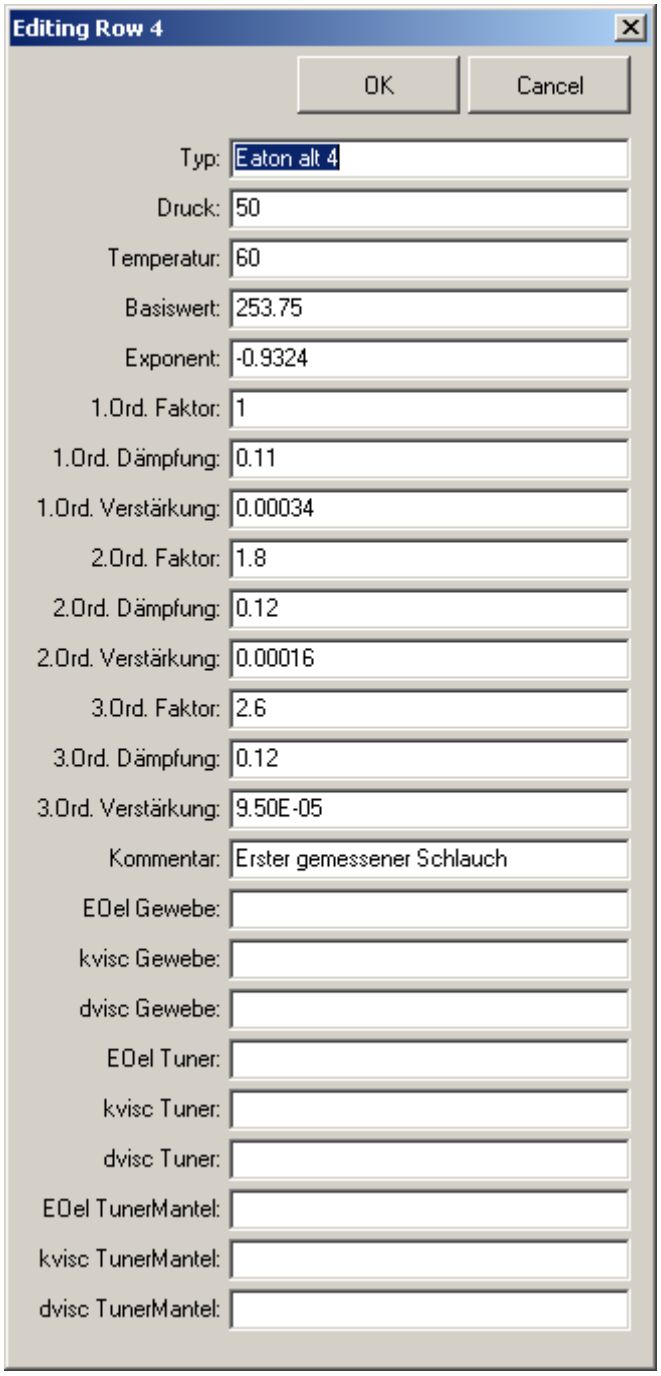


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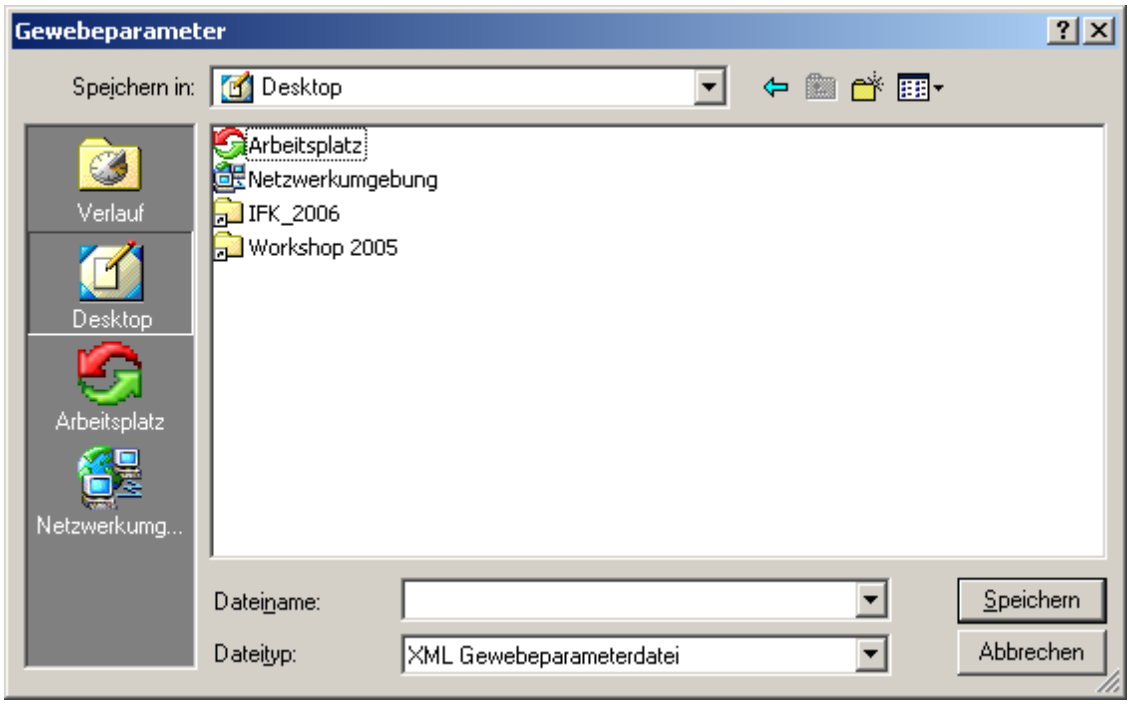
Dialog nach dem Laden von Gewebedaten

Die berechnete temperaturabhängige **Geweberesonanzfrequenz** (für das gleiche Gewebematerial) wird rot als Funktion der Gewebelänge dargestellt. Die blaue, mit der Maus zu verschiebende, senkrechte Linie zeigt im Schnittpunkt die jeweilige Frequenz bei einer bestimmten **Gewebelänge**.

Die Taste **NEU** fügt in der Gewebeliste einen weiteren Parametersatz hinzu, **DELETE** löscht den markierten Parametersatz. Das Editieren der Parametersätze wird durch einen Doppelklick auf die betreffenden Zeile im sich öffnenden Dialog **Editing Row n** möglich. N steht für die Zeilennummer in der Gewebeliste.



Die manuelle Eingabe der Parameter erfolgt ohne Einheiten. Ein zusätzliches Kommentarfeld ist vorhanden. Mit **OK** werden die Parameter in der Gewebeliste sichtbar. Mit **SAVE** in der Gewebeliste öffnet ein Dialog, indem das Zielverzeichnis der *XML*-Datei zu wählen ist.



So gespeicherte XML-Gewebelisten könnnen mit **LOAD** wieder geöffnet werden. Die gespeicherten Gewebelisten müssen nicht im Userverzeichnis liegen.

Anmerkung:
Im Verzeichnis der DSH*plus* Userbibliothek sollte die Datei *„Dehnschlauchbibliothek.xml"* vorhanden sein. Sie enthält beispielhafte Standardparameter für verschiedene Gewebe, die beim Öffnen des Dialoges eingeladen werden.

Ist die Datei nicht im Verzeichnis der User-Bibliothek enthalten, erscheint eine Meldung:



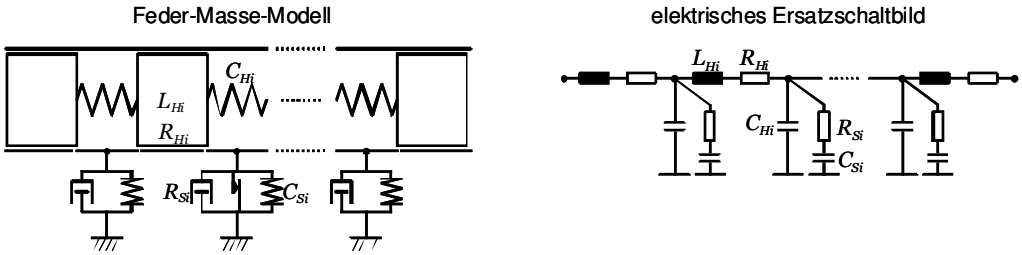
Die Gewebeliste ist nach dem Bestätigen mit **OK** leer, ein Weiterarbeiten ist jedoch möglich.

Grundlegendes zur Gewebeberechnung

Die Berücksichtigung der Gewebewandelastizität entspricht nicht dem physikalischen Aufbau einer Schlauchwand. Die Elastizität wird vielmehr über Ersatzmodelle abgebildet, deren Kennwerte aus dem Vergleich von Messungen und Simulation ermittelt werden müssen.

Der lineare viskoelastische Anteil der Schlauchwanddynamik wird hierbei über die Parameter *kvisc* (viskoelastische Federsteifigkeit) und *dvisc* (viskoelastischer Dämpfungskoeffizient) beschrieben.

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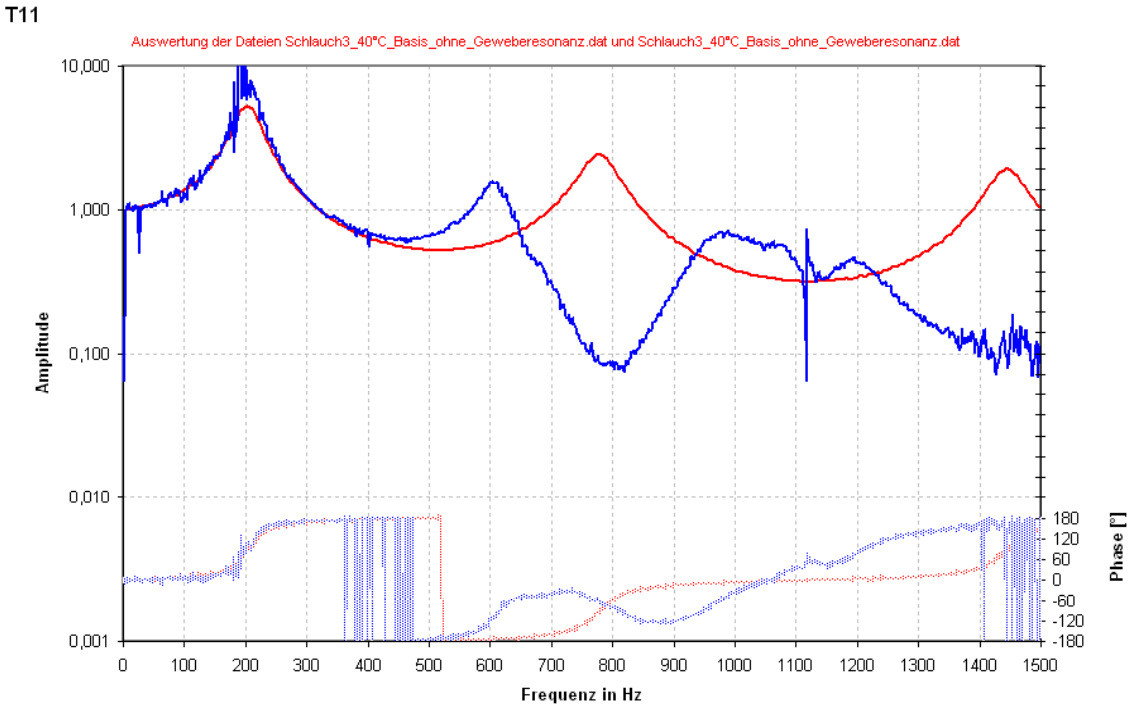


$$\frac{\partial p}{\partial t} + v\frac{\partial p}{\partial x} + E'_{Fl}\left(\frac{\partial v}{\partial x} + \frac{2}{Rd_{visc}}\left(p - k_{visc}y_{visc}\right)\right) = 0$$

Einfluss der Schlauchwand

Erweiterte Kontinuitätsgleichung

Der E-Modul des Gewebestückes (*EOelGewebe*) und die Parameter *kvisc* und *dvisc* werden beim Abgleich von Simulation und Messung so lange variiert, bis die Hauptamplituden und die Phasenlagen der Vierpolmatrizen der Leitung möglichst exakt übereinstimmen (siehe Grafik).



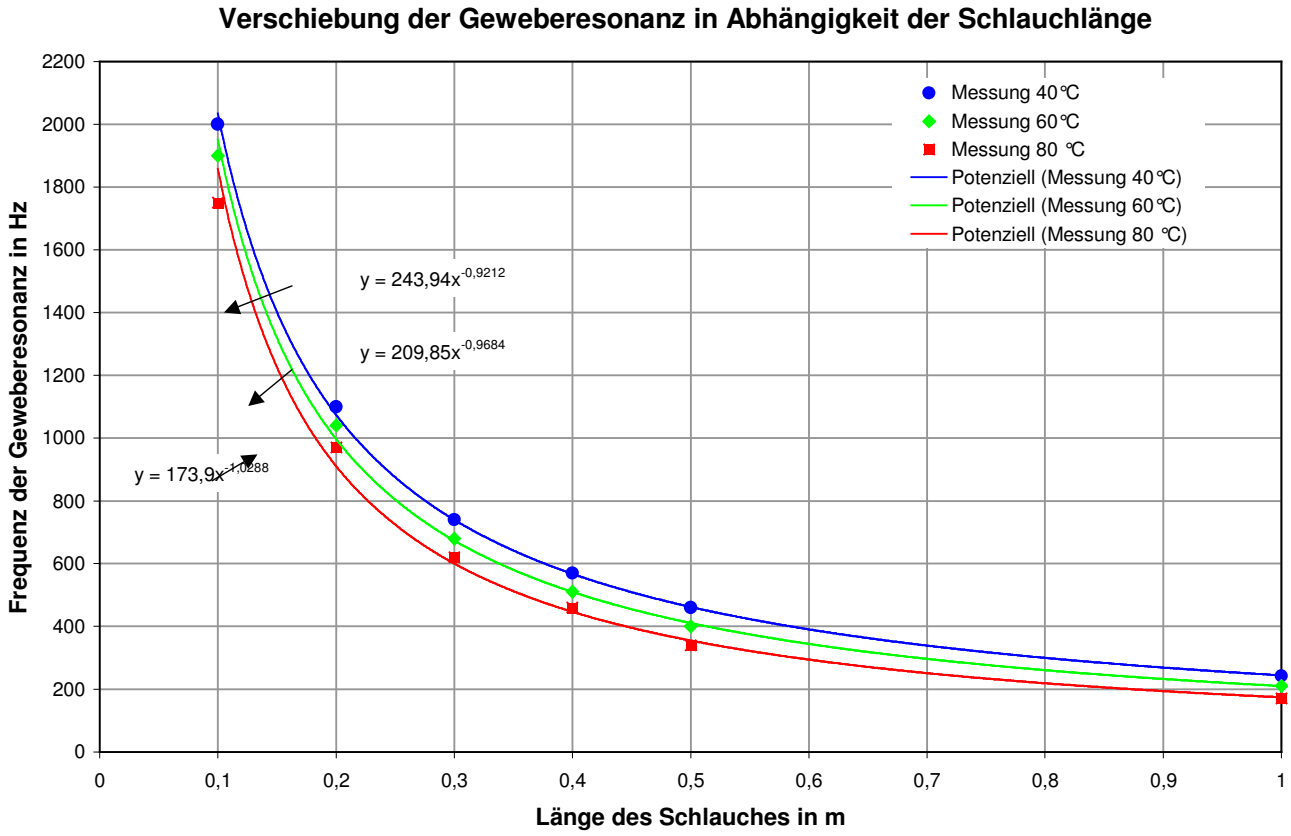
Sind die Parameter *kvisc* und *dvisc* für ein Schlauchwandmaterial identifiziert, so können sie für Leitungen aus gleichem Material, aber mit anderer Länge übernommen werden.

Die Geweberesonanzfrequenz (in der Grafik bei etwa 800 Hz) wird im Schlauchleitungsbauteil durch ein schwingungsfähiges Ersatzsystem dritter Ordnung abgebildet, das parallel zur viskoelastischen Wandelastizität modelliert ist.

Zur Parametrierung des Ersatzmodells werden die Parameter für die Faktoren, die Dämpfungen und die Verstärkungen der 1. bis 3. Ordnung benötigt. Die Parametrierung von Dämpfung und Verstärkung wird wiederum durch den direkten Vergleich mit den Messda-

ten vorgenommen. Auch hier können die Parameter für Leitungen aus gleichem Material, aber unterschiedlicher Länge übernommen werden.

Die Parametrierung der Geweberesonanzfrequenz muss allerdings auf die Länge der Leitung angepasst werden. Dies kann einerseits durch direkte Zahlenangabe (Parameter *Frequenz*) oder andererseits automatisch über eine Regressionsfunktion erfolgen. Die Stützstellen der Regressionsfunktion werden durch Messungen unterschiedlicher Schlauchlängen ermittelt.

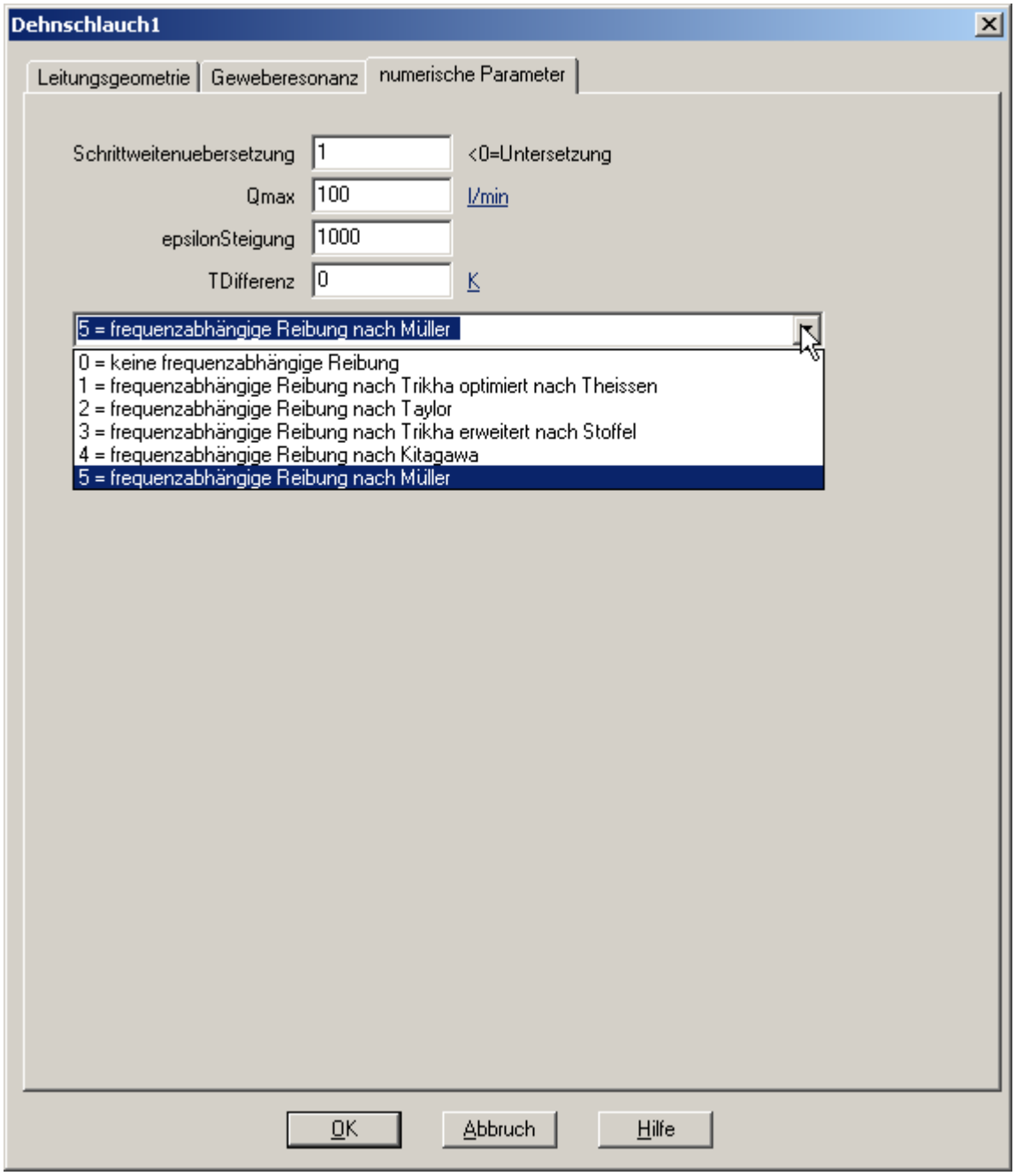


Deutlich ist in der Grafik eine starke Längenabhängigkeit und eine schwächere Temperaturabhängigkeit der Geweberesonanz zu erkennen. Zur Parametrierung der Regressionsfunktion werden die Parameter *Exponent* und *Basiswert* verwendet. Hierfür gilt: eine automatische Ermittlung der Regressionskurve erfolgt nur, wenn der Parameter *Frequenz* gleich Null ist. Wenn bei der Geweberesonanz sowohl eine Frequenz ungleich 0 als auch Exponent und Basiswert angegeben werden, wird in der Simulation nur mit diesem Zahlenwert gerechnet, Exponent und Basis werden in der Berechnung nicht Berücksichtigt.

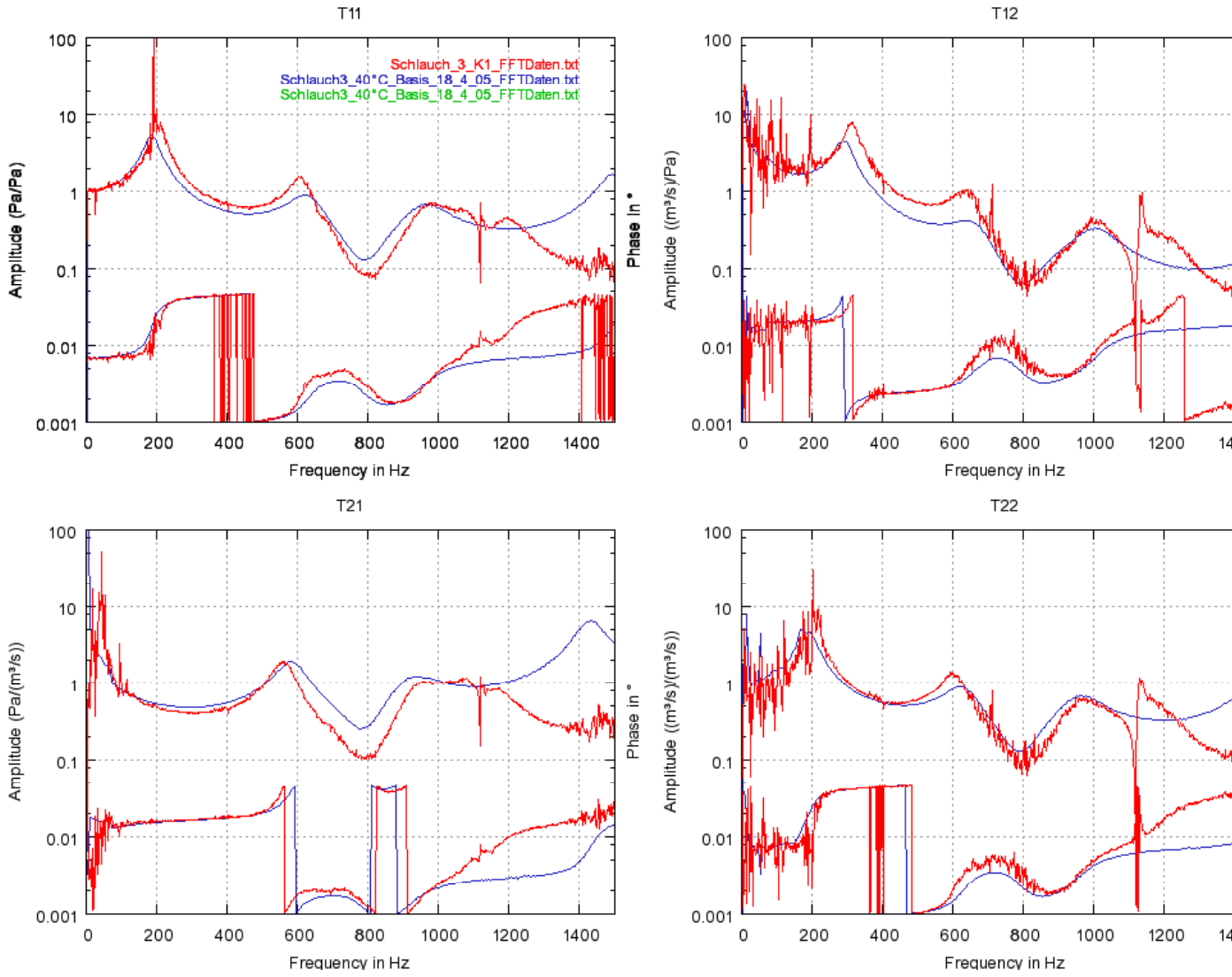
Numerische Randbedingungen

Die Eingabe der numerischen Randbedingungen und die Auswahl des frequenzabhängigen Reibungsansatzes erfolgt im Reiter **numerische Parameter**.

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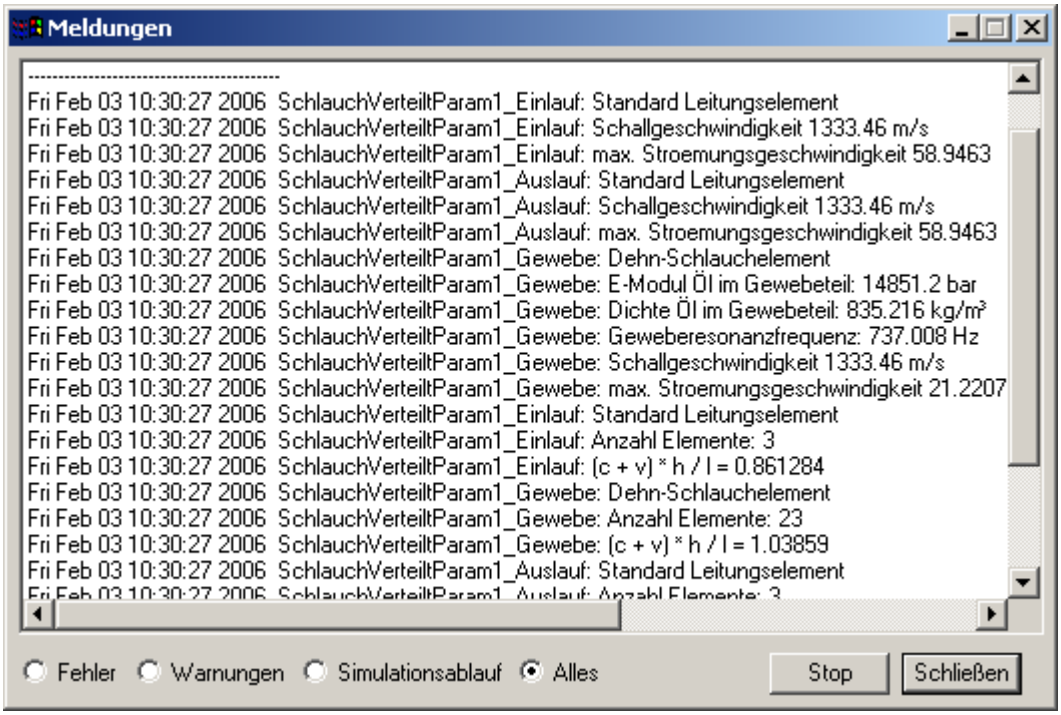


Nachfolgende Grafik zeigt den Ergebnisvergleich von Simulation und Messung mit einem komplett parametrierten Schlauchleitungselement.



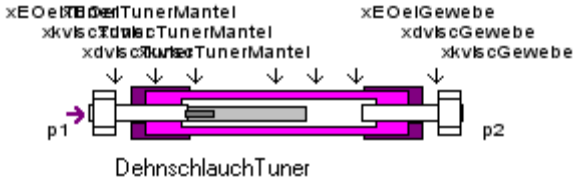
Eine Kontrolle der Parametrierung des Leitungselementes ist ebenfalls möglich. Hierzu werden die numerischen und die dynamischen Parameter des Bauteils nach dem Simulationsstart im DSH*plus*-Meldungsfenster protokolliert.

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Meldungen

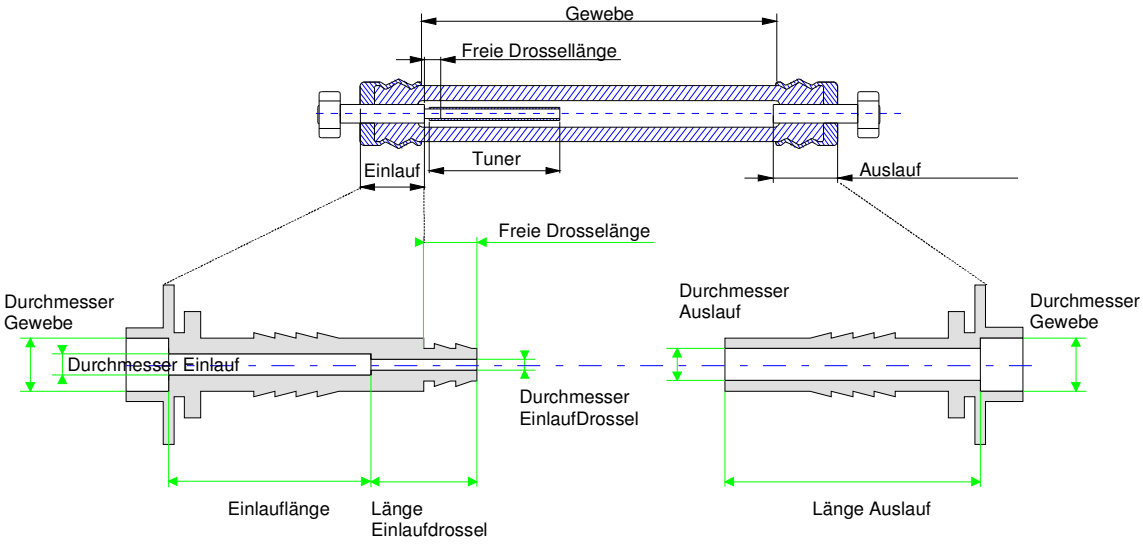
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: Standard Leitungselement
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: Schallgeschwindigkeit 1333.46 m/s
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: max. Stroemungsgeschwindigkeit 58.9463
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Auslauf: Standard Leitungselement
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Auslauf: Schallgeschwindigkeit 1333.46 m/s
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Auslauf: max. Stroemungsgeschwindigkeit 58.9463
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Dehn-Schlauchelement
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: E-Modul Öl im Gewebeteil: 14851.2 bar
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Dichte Öl im Gewebeteil: 835.216 kg/m³
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Geweberesonanzfrequenz: 737.008 Hz
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Schallgeschwindigkeit 1333.46 m/s
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: max. Stroemungsgeschwindigkeit 21.2207
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: Standard Leitungselement
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: Anzahl Elemente: 3
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Einlauf: (c + v) * h / l = 0.861284
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Dehn-Schlauchelement
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: Anzahl Elemente: 23
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Gewebe: (c + v) * h / l = 1.03859
Fri Feb 03 10:30:27 2006 SchlauchVerteiltParam1_Auslauf: Standard Leitungselement
Fehler
Warnungen
Simulationsablauf
Alles
Stop
Schließen

DehnschlauchTuner



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Druck am Rohrende 1
p2	Hvol	bar	Druck am Rohrende 2
xEOelGewebe	Ein	bar	Kompressionsmodul des Öls im Schlauchstück
xdviscGewebe	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Schlauchs
xkviscGewebe	Ein	bar/m	externer viskoelastischer Anteil der Schlauchsteifigkeit
xEOelTunerMantel	Ein	bar	externer Kompressionsmodul des Öls im Tunermantel
xdviscTunerMantel	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tunermantel

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xkviscTunerMantel	Ein	bar/m	externer viskoelastischer Anteil des Tunermantel
XEOelTuner	Ein	bar	externer Kompressionsmodul des Öls im Tuner
XdviscTuner	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tuners
xkviscTuner	Ein	bar/m	externer viskoelastischer Anteil des Tuners
pTunerEingang	Aus	bar	Druck am Übergang von Tunernippel zur Tunerleitung
pTunerWurzel	Aus	bar	Druck an der Tunerwurzel

Parameters

Name	Standardwert/ Standardeinheit		Description
LaengeEinlauf	38,5	mm	Gesamtlänge des Einlaufstücks
LaengeEinlaufDrossel	20	mm	Gesamtlänge der Einlaufdrossel
FreieDrosselLaenge	0	mm	Länge des Einlaufdrosselstücks im Tuner
LaengeGewebe	400	mm	Gesamtlänge des Gewebestücks
LaengeTuner	370	mm	Gesamtlänge des Tuners
LaengeAuslauf	48,5	mm	Gesamtlänge des Auslaufstücks
DurchmesserEinlauf	6	mm	Innendurchmesser des Einlaufstücks
DurchmesserEinlaufDrossel	3	mm	Innendurchmesser der Einlaufdrossel
DurchmesserGewebe	10	mm	Innendurchmesser des Gewebestücks
DurchmesserTuner	4	mm	Innendurchmesser des Tunerstücks
TunerDicke	1	mm	Wandstärke des Tuners
DurchmesserAuslauf	6	mm	Innendurchmesser des Auslaufstücks
EOelGewebe	1200	bar	Kompressionsmodul des Öls im Schlauchstück
EOelTuner	2250	bar	Kompressionsmodul des Öls im Tuner

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Name	Standardwert/ Standard-einheit		Description
EOelTunerMantel	430	bar	Kompressionsmodul des Öls im Tunermantel
TDifferenz	0	K	Abweichung der lokalen Temperatur von der globalen Systemtemperatur
Schrittweitenuebersetzung	1	<0=Untersetzung	Verhältnis der Rohrschrittweite zur Simulationsschrittweite -10 == 10 Zwischenschritte pro Simulationsschritt 10 == Aktualisierung alle 10 Simulationsschritte
Qmax	100	l/min	Maximaler Volumenstrom im Leitungselement
ReibungsAnsatz	5	-	Art der Reibungsbeschreibung 0 = frequenzabhängige Reibung aus 1 = Trikha optimiert nach Theissen 2 = Taylor 3 = Trikha erweitert nach Stoffel 4 = Kitagawa 5 = frequenzabh. Reibung nach Müller
epsilonSteigung	1000	-	Faktor bei der Interpolation der Steigung der Charakteristiken
kviscGewebe	9e5	bar/m	viskoelastischer Anteil der Schlauchsteifigkeit
dviscGewebe	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Schlauchs
kviscTuner	1e5	bar/m	viskoelastischer Anteil der Tunersteifigkeit
dviscTuner	5e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tuners
kviscTunerMantel	5e5	bar/m	viskoelastischer Anteil der Tunermantelsteifigkeit

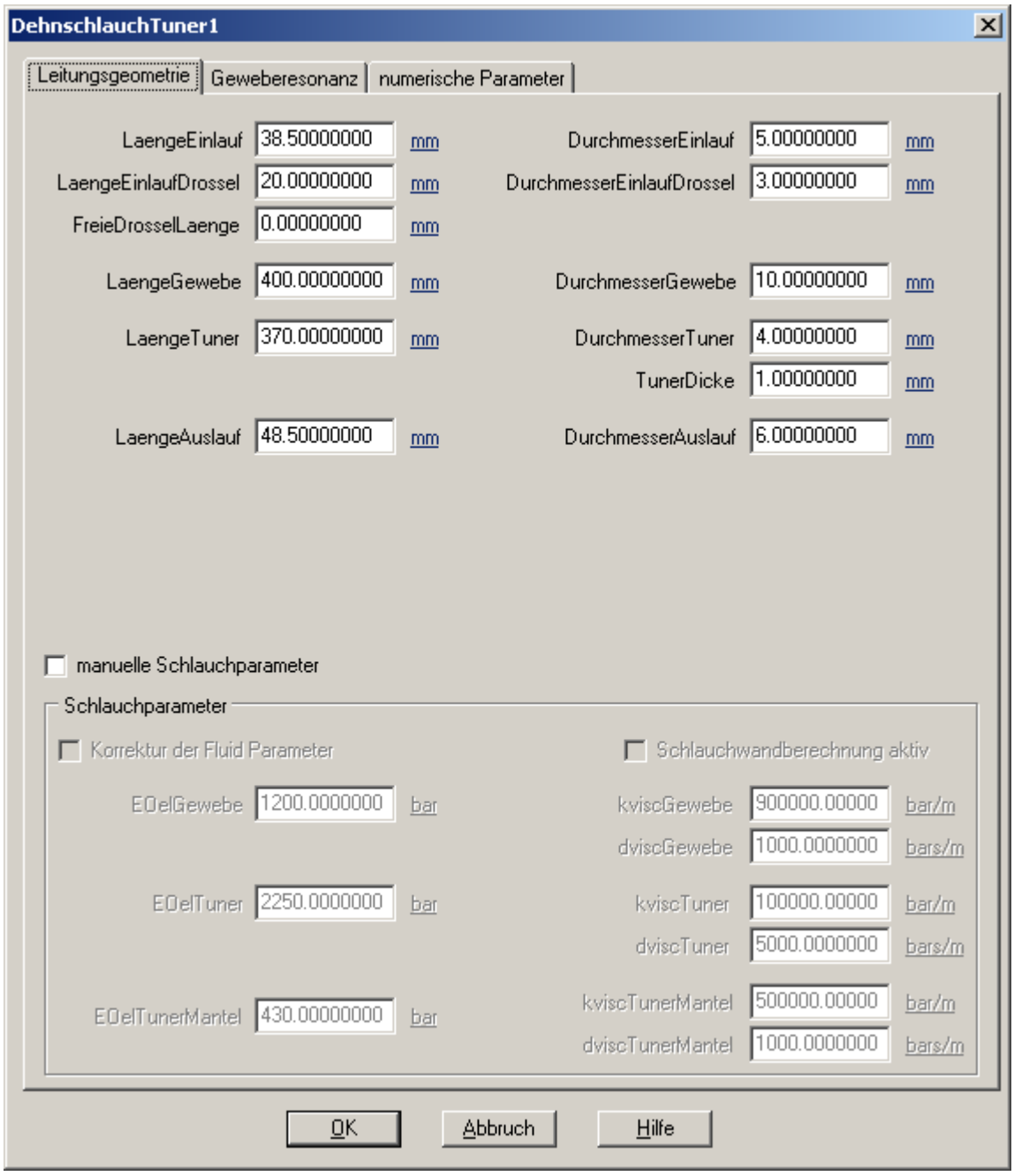
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Name	Standardwert/ Standard-einheit		Description
dviscTunerMantel	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tunermantel
Frequenz	0	Hz	Eigenfrequenz der nichtlinearen Dämpfung des Schlauchs
Exponent	-,9242	-	Exponent der Geweberesonanzgleichung bei t = 40°C
Basiswert	242,23	-	Basiswert der Geweberesonanzgleichung bei t = 40°C
FrequenzfaktorOrd1	1	-	Frequenzfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd1	0,105	-	Dämpfungsfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd1	0,0004	mm/bar	Verstärkungsfaktor der 1. Ordnung der nichtlinearen Dämpfung des Schlauchs
FrequenzfaktorOrd2	1,8	-	Frequenzfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd2	0,11	-	Dämpfungsfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd2	0,0002	mm/bar	Verstärkungsfaktor der 2. Ordnung der nichtlinearen Dämpfung des Schlauchs
FrequenzfaktorOrd3	2,6	-	Frequenzfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs
DaempfungOrd3	0,12	-	Dämpfungsfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs
VerstaerkungOrd3	9e-5	mm/bar	Verstärkungsfaktor der 3. Ordnung der nichtlinearen Dämpfung des Schlauchs

Bemerkungen

Das Bauteil DEHNSCHLAUCHTUNER ist die Zusammenfassung mehrer verteiltparametrischer Leitungselemente mit dem Ziel, das dynamische Übertragungsverhalten eines Dehnschlauches mit eingebautem Tuner abzubilden.

Die Parametrierung erfolgt in einem speziellen Dialog. Die Vorgehensweise zur Parametrierung ist analog zum Bauteil DEHNSCHLAUCH und dort ausführlich beschrieben.



Das Bauteil setzt sich aus je einem Einlauf- und Auslaufstück sowie einer Drossel, die als verteiltparametrische Stahlleitung abgebildet sind, einem Schlauchleitungselement, das die dynamischen Eigenschaften der Schlauchwand berücksichtigt und einem Rohrelement für die Berücksichtigung der dynamischen Eigenschaften des Tuners zusammen.

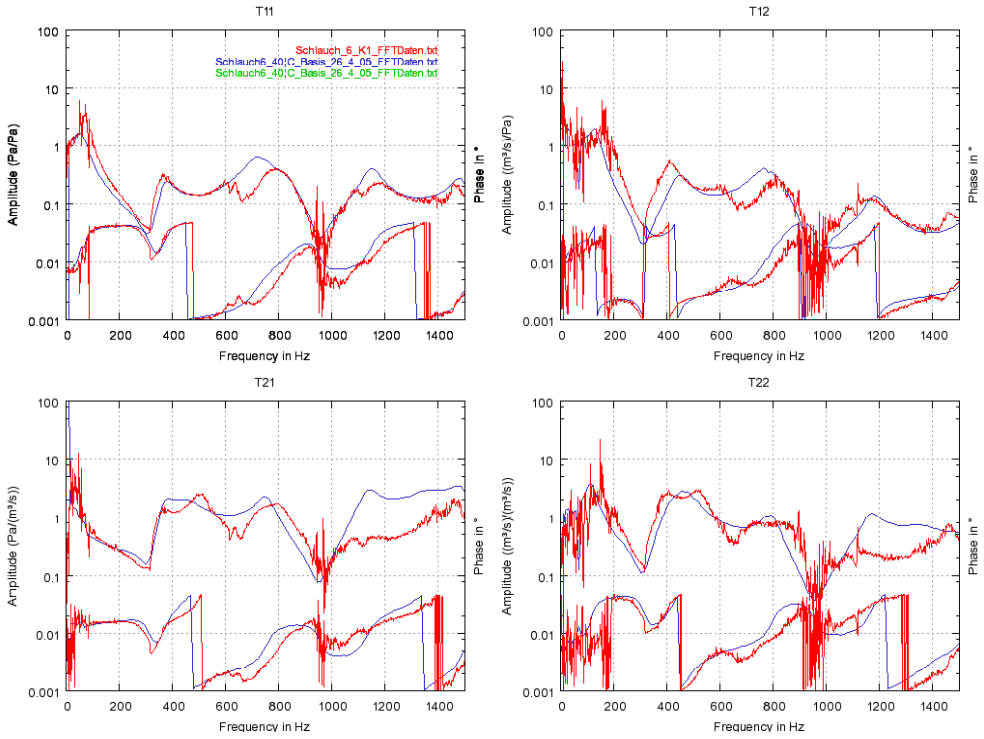
Die Berücksichtigung der Gewebewandelastizität entspricht nicht dem physikalischen Aufbau einer Schlauchwand. Die Elastizität wird vielmehr über Ersatzmodelle abgebildet, deren Kennwerte aus dem Vergleich von Messungen und Simulation ermittelt werden müssen.

Die Gesamtparametrierung des Bauteils SCHLAUCHTUNERVERTEILTPARAM setzt die Kenntnis der Parameter des Gewebestückes *EOelGewebe*, *kviscGewebe* und *dviscGewebe* in erster

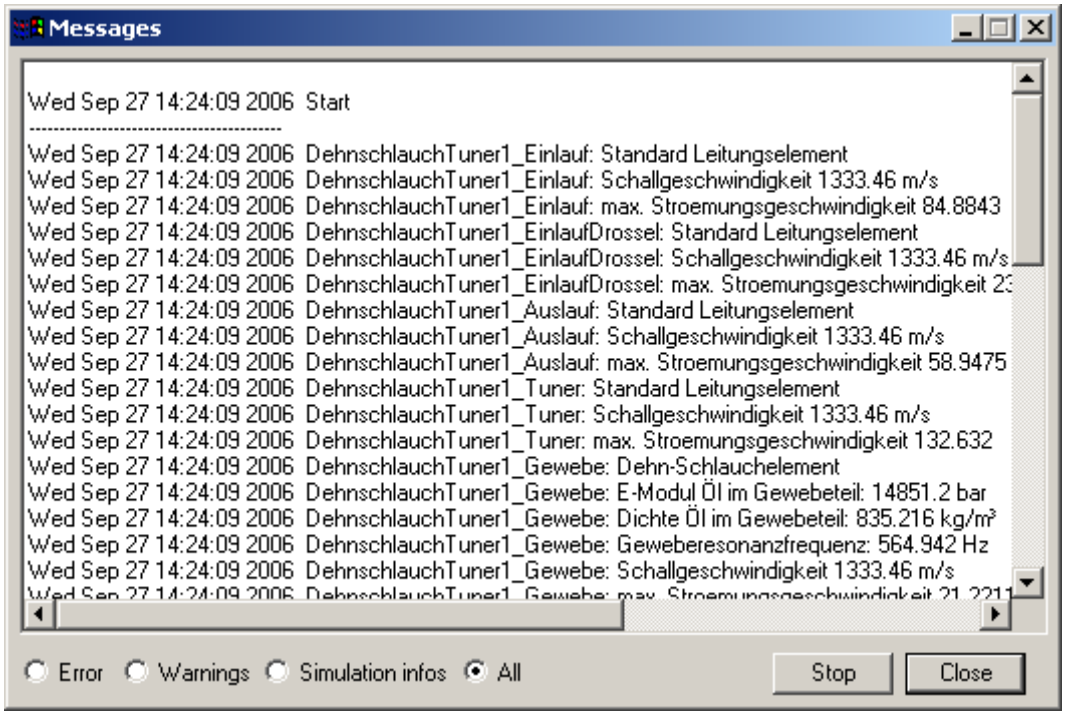
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Näherung voraus. Die Vorgehensweise zur Ermittlung dieser Werte ist im Bauteil Dehnschlauch beschrieben.

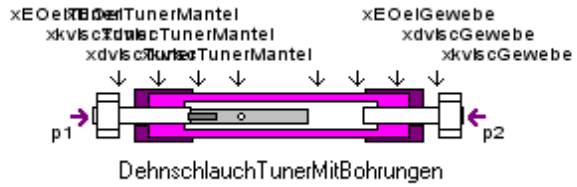
Die nachfolgende Grafik zeigt den Ergebnisvergleich von Simulation und Messung mit einem komplett parametrierten Schlauch-Tuner-Leitungselement.



Eine Kontrolle der Parametrierung des Leitungselementes ist ebenfalls möglich. Hierzu werden die numerischen und die dynamischen Parameter des Bauteils nach dem Simulationsstart im DSH*plus*-Meldungsfenster protokolliert.

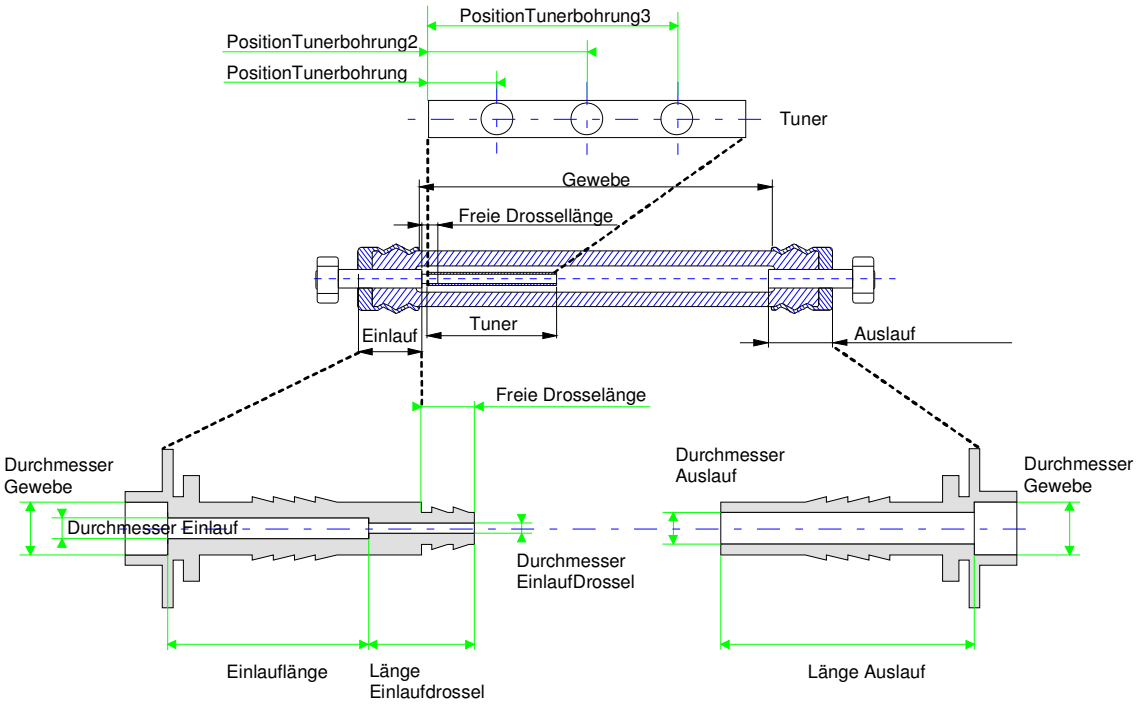


DehnschlauchTunerMitBohrungen



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Druck am Rohrende 1
p2	Hvol	bar	Druck am Rohrende 2
xEOelGewebe	Ein	bar	externer Kompressionsmodul des Öls im Schlauchstück
xdviscGewebe	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Schlauchs
xkviscGewebe	Ein	bar/m	externer viskoelastischer Anteil der Schlauchsteifigkeit

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xEOelTunerMantel	Ein	bar	externer Kompressionsmodul des Öls im Tunermantel
xdviscTunerMantel	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tunermantel
xkviscTunerMantel	Ein	bar/m	externer viskoelastischer Anteil des Tunermantel
XEOelTuner	Ein	bar	externer Kompressionsmodul des Öls im Tuner
XdviscTuner	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tuners
xkviscTuner	Ein	bar/m	externer viskoelastischer Anteil des Tuners

Parameters

Name	Value/Unit		Description
LaengeEinlauf	38,5	mm	Gesamtlänge des Einlaufstücks
LaengeEinlaufDrossel	20	mm	Gesamtlänge der Einlaufdrossel
FreieDrosselLaenge	0	mm	Länge des Tuners in der Drossel
LaengeGewebe	200	mm	Gesamtlänge des Gewebestücks
LaengeTuner	150	mm	Gesamtlänge des Tuners
LaengeAuslauf	48,5	mm	Gesamtlänge des Auslaufstücks
DurchmesserEinlauf	5	mm	Innendurchmesser des Einlaufstücks
DurchmesserEinlaufDrossel	3	mm	Innendurchmesser der Einlaufdrossel
DurchmesserGewebe	10	mm	Innendurchmesser des Gewebestücks
DurchmesserTuner	4	mm	Innendurchmesser des Tunerstücks
DurchmesserAuslauf	6	mm	Innendurchmesser des Auslaufstücks
DurchmesserTunerBohrung	2	mm	Innendurchmesser der Tunerbohrung
TunerDicke	1	mm	Wandstärke des Tuners

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Name	Value/Unit		Description
Bohrungspositionen	1		Anzahl der Tunerbohrung mindestens 1 maximal 3 (zur Zeit)
PositionTunerBohrung	80	mm	Position der 1. Tunerbohrung
PositionTunerBohrung2	100	mm	Position der 2. Tunerbohrung
PositionTunerBohrung3	120	mm	Position der 3. Tunerbohrung
Volumenstrom	1.366	l/min	Volumenstrom durch die Tunerbohrung bei anliegender Druckdifferenz
Druckdifferenz	10	bar	s.o
Widerstandsexponent	0.7		Exponent für die Abhängigkeit von anliegender Druckdifferenz und Volumenstrom 1 = lineare Abhängigkeit 2 = wurzelförmig
EOelGewebe	2950	bar	Kompressionsmodul des Öls im Schlauchstück
EOelTuner	1550	bar	Kompressionsmodul des Öls im Tuner
EOelTunerMantel	475	bar	Kompressionsmodul des Öls im Tunermantel
TDifferenz	0	K	Abweichung der lokalen Temperatur von der globalen Systemtemperatur
Schrittweitenuebersetzung	1	<0=Untersetzung	Verhältnis der Rohrschrittweite zur Simulationsschrittweite -10 == 10 Zwischenschritte pro Simulationsschritt 10 == Aktualisierung alle 10 Simulationsschritte
Qmax	100	l/min	Maximaler Volumenstrom im Leitungselement

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Name	Value/Unit		Description
ReibungsAnsatz	5	-	Art der Reibungsbeschreibung 0 = frequenzabhängige Reibung aus 1 = Trikha optimiert nach Theissen 2 = Taylor 3 = Trikha erweitert nach Stoffel 4 = Kitagawa 5 = frequenzabh. Reibung nach Müller
epsilonSteigung	1000	-	Faktor bei der Interpolation der Steigung der Charakteristiken
kviscGewebe	9e5	bar/m	viskoelastischer Anteil der Schlauchsteifigkeit
dviscGewebe	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Schlauchs
kviscTuner	1e5	bar/m	viskoelastischer Anteil der Tunersteifigkeit
dviscTuner	5e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tuners
kviscTunerMantel	5e5	bar/m	viskoelastischer Anteil der Tunermantelsteifigkeit
dviscTunerMantel	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tunermantels
Frequenz	0	Hz	Eigenfrequenz der nichtlinearen Dämpfung des Schlauchs
Exponent	-,9242	-	Exponent der Geweberesonanzgleichung bei t = 40°C
Basiswert	242,23	-	Basiswert der Geweberesonanzgleichung bei t = 40°C
FrequenzfaktorOrd1	1	-	Verschiebungsfaktor Frequenz zur angegebenen Regression

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Name	Value/Unit		Description
DaempfungOrd1	0,11	-	Dämpfungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
VerstaerkungOrd1	3,4e-4	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
FrequenzfaktorOrd2	1,8	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd2	0,12	-	Dämpfungsfaktorder nichtlinearen Dämpfung zweiter Ordnung des Schlauchs
VerstaerkungOrd2	1,6e-4	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung zweiter Ordnung des Schlauchs
FrequenzfaktorOrd3	2,6	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd3	0,12	-	Dämpfungsfaktorder nichtlinearen Dämpfung dritter Ordnung des Schlauchs
VerstaerkungOrd3	9,5e-5	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung dritter Ordnung des Schlauchs

Bemerkungen

Das Bauteil DEHNSCHLAUCHTUNERMITBOHRUNGEN ist die Zusammenfassung mehrer verteiltparametrischer Leitungselemente mit dem Ziel, das dynamische Übertragungsverhalten eines Dehnschlauches mit eingebautem Tuner abzubilden.

Das Bauteil setzt sich aus je einem Einlauf- und Auslaufstück sowie einer Drossel, die als verteiltparametrische Stahlleitung abgebildet sind, einem Schlauchleitungselement, das die dynamischen Eigenschaften der Schlauchwand berücksichtigt und einem Rohrelement für die Berücksichtigung der dynamischen Eigenschaften des Tuners sowie mindestens einer, maximal drei Tunerbohrungen, die iterativ als Blende berechnet werden, zusammen.

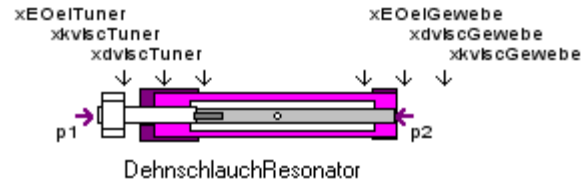
Die Anzahl der berechneten Tunerbohrungen ist gleich der Anzahl der *Bohrungspositionen*, unabhängig davon ob mehrere Tunerbohrungen parametriert sind. Es wird mindestens eine Bohrung benötigt, um die Berechnung zu starten. Dabei wird die Bohrung gerechnet, die den kleinsten Abstand zum Einlauf aufweist.

Die Berücksichtigung der Gewebewandelastizität entspricht nicht dem physikalischen Aufbau einer Schlauchwand. Die Elastizität wird vielmehr über Ersatzmodelle abgebildet, deren Kennwerte aus dem Vergleich von Messungen und Simulation ermittelt werden müssen.

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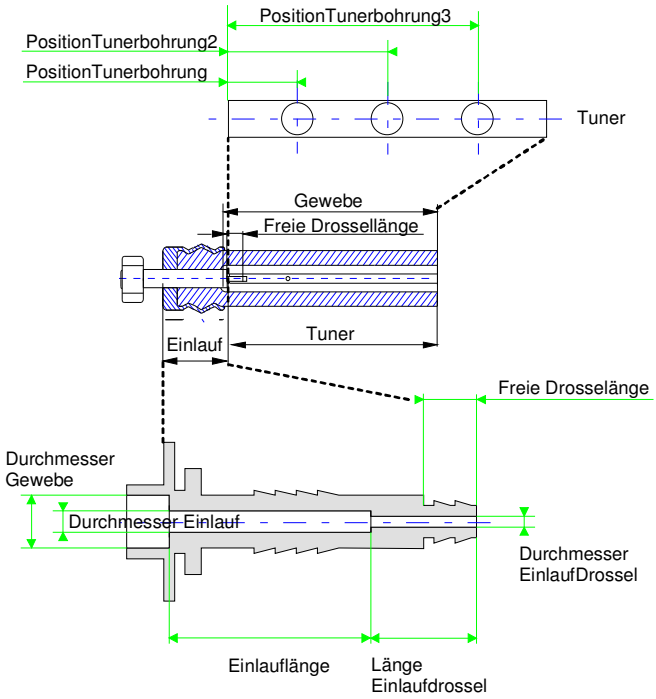
Die Gesamtparametrierung des Bauteils DEHNSCHLAUCHTUNERMITBOHRUNGEN setzt die Kenntnis der Parameter des Gewebestückes *EOelGewebe*, *kviscGewebe* und *dviscGewebe* in erster Näherung voraus. Die Vorgehensweise zur Ermittlung dieser Werte ist im Bauteil Dehnschlauch beschrieben.

DehnschlauchResonator



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Druck am Rohrende 1
p2	Hvol	bar	Druck am Rohrende 2
xEOelGewebe	Ein	bar	Kompressionsmodul des Öls im Schlauchstück
xdviscGewebe	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Schlauchs
xkviscGewebe	Ein	bar/m	externer viskoelastischer Anteil der Schlauchsteifigkeit
XEOelTuner	Ein	bar	externer Kompressionsmodul des Öls im Tuner

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XdviscTuner	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tuners
xkviscTuner	Ein	bar/m	externer viskoelastischer Anteil des Tuners

Parameters

Name	Value/Unit		Description
LaengeEinlauf	38,5	mm	Gesamtlänge des Einlaufstücks
LaengeEinlaufDrossel	20	mm	Gesamtlänge der Einlaufdrossel
FreieDrosselLaenge	0	mm	Länge des Tuners im Drosselstück
LaengeGewebe	200	mm	Gesamtlänge des Gewebestücks
DurchmesserEinlauf	5	mm	Innendurchmesser des Einlaufstücks
DurchmesserEinlaufDrossel	3	mm	Innendurchmesser der Einlaufdrossel
DurchmesserGewebe	10	mm	Innendurchmesser des Gewebestücks
DurchmesserTuner	4	mm	Innendurchmesser des Tuners
Bohrungspositionen	1		Anzahl der Tunerbohrung mindestens 1 maximal 3 (zur Zeit)
PositionTunerBohrung	80	mm	Position der 1. Tunerbohrung
PositionTunerBohrung2	100	mm	Position der 2. Tunerbohrung
PositionTunerBohrung3	120	mm	Position der 3. Tunerbohrung
Volumenstrom	10,928	l/min	Volumenstrom durch die Tunerbohrung bei anliegender Druckdifferenz
Druckdifferenz	10	bar	s.o.
WiderstandExponent	0,7		Exponent für die Abhängigkeit von anliegender *Druckdifferenz* und *Volumenstrom* *1 = lineare Abhängigkeit* *0 = wurzelförmig*
TunerDicke	1	mm	Wandstärke des Tuners
EoelGewebe	1200	bar	Kompressionsmodul des Öls im Schlauchstück
EoelTuner	2250	bar	Kompressionsmodul des Öls im Tuner

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Name	Value/Unit		Description
TDifferenz	0	K	Abweichung der lokalen Temperatur von der globalen Systemtemperatur
Schrittweitenuebersetzung	1	<0=Untersetzung	Verhältnis der Rohrschrittweite zur Simulationsschrittweite -10 == 10 Zwischenschritte pro Simulationsschritt 10 == Aktualisierung alle 10 Simulationsschritte
Qmax	100	l/min	Maximaler Volumenstrom im Leitungselement
ReibungsAnsatz	5	-	Art der Reibungsbeschreibung 0 = frequenzabhängige Reibung aus 1 = Trikha optimiert nach Theissen 2 = Taylor 3 = Trikha erweitert nach Stoffel 4 = Kitagawa 5 = frequenzabh. Reibung nach Ml
EpsilonSteigung	1000	-	Faktor bei der Interpolation der Steigung der Charakteristiken
kviscGewebe	9e5	bar/m	viskoelastischer Anteil der Schlauchsteifigkeit
dviscGewebe	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Schlauchs
kviscTuner	1e5	bar/m	viskoelastischer Anteil der Tunersteifigkeit
dviscTuner	5e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tuners
Frequenz	0	Hz	Eigenfrequenz der nichtlinearen Dämpfung des Schlauchs
Exponent	-,9242	-	Exponent der Geweberesonanzgleichung bei t=40°C
Basiswert	242,23	-	Basiswert der Geweberesonanzgleichung bei t=40°C
FrequenzfaktorOrd1	1	-	Verschiebungsfaktor Frequenz zur angegebenen Regression

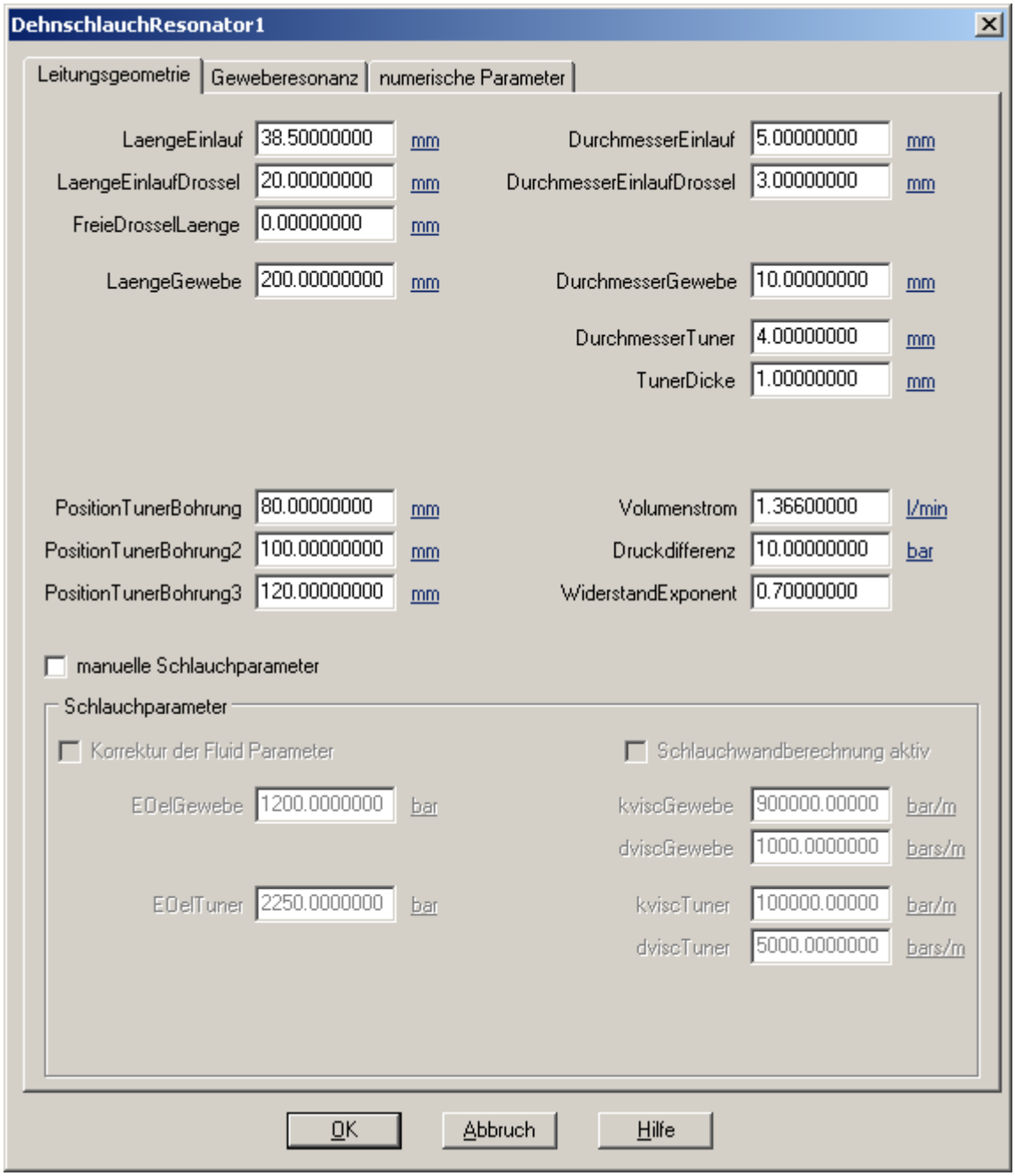
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Name	Value/Unit		Description
DaempfungOrd1	0,15	-	Dämpfungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
VerstaerkungOrd1	0,0004	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
FrequenzfaktorOrd2	1,8	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd2	0,11	-	Dämpfungsfaktorder nichtlinearen Dämpfung zweiter Ordnung des Schlauchs
VerstaerkungOrd2	0,0002	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung zweiter Ordnung des Schlauchs
FrequenzfaktorOrd3	2,6	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd3	0,12	-	Dämpfungsfaktorder nichtlinearen Dämpfung dritter Ordnung des Schlauchs
VerstaerkungOrd3	9,5e-5	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung dritter Ordnung des Schlauchs

Bemerkungen

Das Bauteil DEHNSCHLAUCHRESONATOR ist die Zusammenfassung mehrerer verteiltparametrischer Leitungselemente mit dem Ziel, das dynamischen Übertragungsverhalten eines Dehnschlauches mit eingebauten Helmholzresonator abzubilden.

Die Parametrierung erfolgt in einem speziellen Dialog. Die Vorgehensweise zur Parametrierung ist analog zum Bauteil DEHNSCHLAUCH und dort ausführlich beschrieben.



Das Bauteil setzt sich aus einem Einlaufstück und einer Drossel, die als verteiltparametrische Stahlleitungen abgebildet sind, einem Schlauchleitungselement, das die dynamischen Eigenschaften der Schlauchwand berücksichtigt, einem Rohrelement, für die Berücksichtigung der dynamischen Eigenschaften des Tuners sowie mindestens einer, maximal drei Tunerbohrungen, die iterativ als Blende berechnet werden, zusammen.

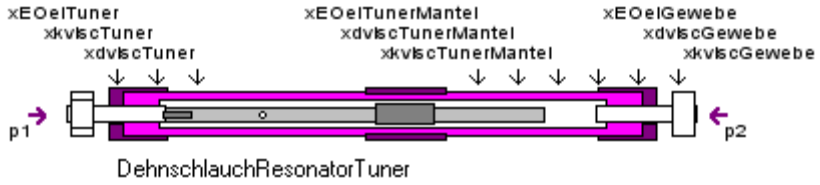
Die Anzahl der berechneten Tunerbohrungen ist gleich der Anzahl der *Bohrungspositionen*, unabhängig davon ob mehrere Tunerbohrungen parametriert sind. Es wird mindestens eine Bohrung benötigt, um die Berechnung zu starten. Dabei wird die Bohrung gerechnet, die den kleinsten Abstand zum Einlauf aufweist.

Die Berücksichtigung der Gewebewandelastizität entspricht nicht dem physikalischen Aufbau einer Schlauchwand. Die Elastizität wird vielmehr über Ersatzmodelle abgebildet, deren Kennwerte aus dem Vergleich von Messungen und Simulation ermittelt werden müssen.

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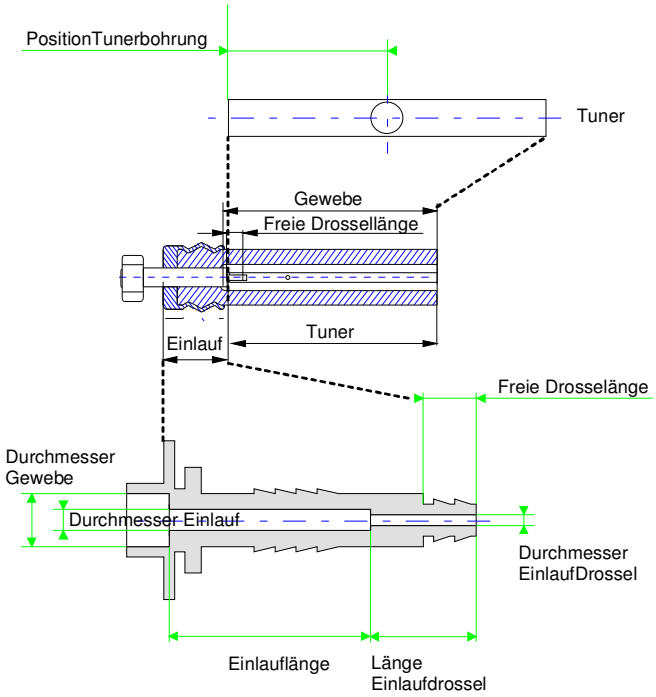
Die Gesamtparametrierung des Bauteils DEHNSCHLAUCHRESONATOR setzt daher die Kenntnis der Parameter des Gewebestückes *EOelGewebe*, *kviscGewebe* und *dviscGewebe* in erster Näherung voraus. Die Vorgehensweise zur Ermittlung dieser Werte ist im Bauteil Dehnschlauch beschrieben.

DehnschlauchResonatorTuner



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Druck am Rohrende 1
p2	Hvol	bar	Druck am Rohrende 2
xEOelGewebe	Ein	bar	Kompressionsmodul des Öls im Schlauchstück
xdviscGewebe	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Schlauchs
xkviscGewebe	Ein	bar/m	externer viskoelastischer Anteil der Schlauchsteifigkeit
XEOelTuner	Ein	bar	externer Kompressionsmodul des Öls im Tuner

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XdviscTuner	Ein	bars/m	externer viskoelastischer Dämpfungskoeffizient des Tuners
xkviscTuner	Ein	bar/m	externer viskoelastischer Anteil des Tuners

Parameters

Name	Standardwert/ Standardeinheit		Description
LaengeEinlauf	38,5	mm	Gesamtlänge des Einlaufstücks
LaengeEinlaufDrossel	20	mm	Gesamtlänge der Einlaufdrossel
FreieDrosselLaenge	0	mm	Länge des Tuners im Drosselstück
LaengeGewebeHelmholz	200	mm	Gesamtlänge des Gewebestücks
LaengeZwischenstueck	40	mm	Gesamtlänge des Gewebezwischenstücks
LaengeGewebeTuner	400	mm	Gesamtlänge des Gewebestücks
LaengeTuner	370	mm	Gesamtlänge des Tuners
LaengeAuslauf	48,5	mm	Gesamtlänge des Auslaufs
DurchmesserEinlauf	5	mm	Innendurchmesser des Einlaufstücks
DurchmesserEinlaufDrossel	3	mm	Innendurchmesser der Einlaufdrossel
DurchmesserGewebe	10	mm	Innendurchmesser des Gewebestücks
DurchmesserTuner	4	mm	Innendurchmesser des Tuners
DurchmesserTunerBohrung	2	mm	Durchmesser der Tunerbohrung
DurchmesserAuslauf	6	mm	Durchmesser des Auslaufs
PositionTunerBohrung	100	mm	Position der Tunerbohrung
TunerDicke	1	mm	Wandstärke des Tuners
ZwischenStueckSpaltHoehe	0,1	mm	Spalthöhe
Exzentrizitaet	0	%	Exzentrizität des Spalts
EoelGewebe	1200	bar	Kompressionsmodul des Öls im Schlauchstück
EoelTuner	2250	bar	Kompressionsmodul des Öls im Tuner
EoelTunerMantel	430	bar	Kompressionsmodul des Öls im Tunermantel

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Name	Standardwert/ Standardeinheit		Description
TDifferenz	0	K	Abweichung der lokalen Temperatur von der globalen Systemtemperatur
Schrittweitenuebersetzung	1	<0=Untersetzung	Verhältnis der Rohrschrittweite zur Simulationsschrittweite -10 == 10 Zwischenschritte pro Simulationsschritt 10 == Aktualisierung alle 10 Simulationsschritte
Qmax	100	l/min	Maximaler Volumenstrom im Leitungselement
ReibungsAnsatz	5	-	Art der Reibungsbeschreibung 0 = frequenzabhängige Reibung aus 1 = Trikha optimiert nach Theissen 2 = Taylor 3 = Trikha erweitert nach Stoffel 4 = Kitagawa 5 = frequenzabh. Reibung nach Ml
EpsilonSteigung	1000	-	Faktor bei der Interpolation der Steigung der Charakteristiken
kviscGewebe	9e5	bar/m	viskoelastischer Anteil der Schlauchsteifigkeit
dviscGewebe	1e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Schlauchs
kviscTuner	1e5	bar/m	viskoelastischer Anteil der Tunersteifigkeit
dviscTuner	5e3	bars/m	viskoelastischer Dämpfungskoeffizient des Tuners
kviscTunerMantel	1e5	bar/m	viskoelastischer Anteil der Tunermantelsteifigkeit
dviscTunerMantel	5e3	bars/m	Viskoelastischer Dämpfungskoeffizient des Tunermantels
Frequenz	0	Hz	Eigenfrequenz der nichtlinearen Dämpfung des Schlauchs
Exponent	-,9242	-	Exponent der Gewebereonanzgleichung bei t=40°C

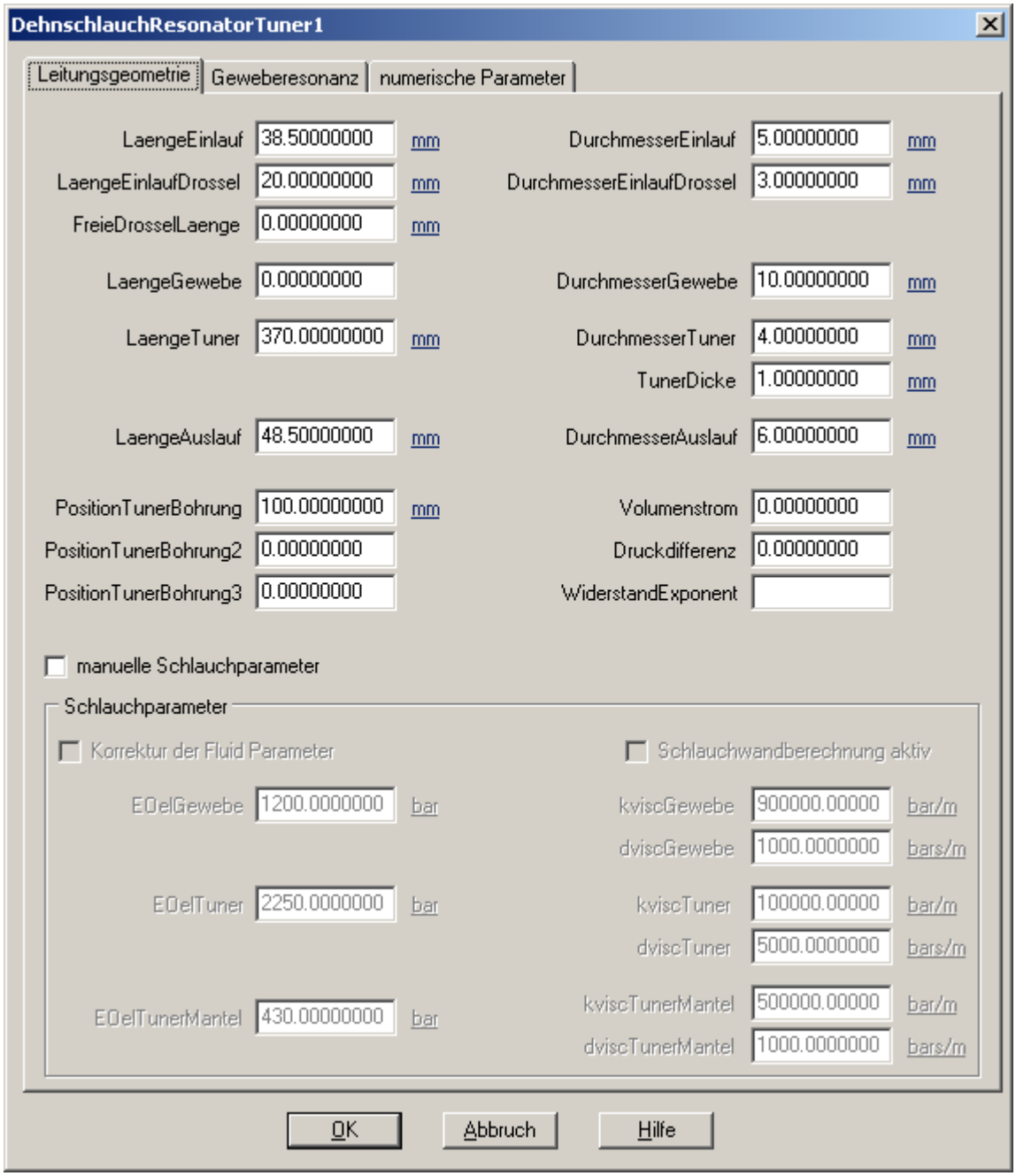
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Name	Standardwert/ Standardeinheit		Description
Basiswert	242,23	-	Basiswert der Geweberenonanzgleichung bei t=40°C
FrequenzfaktorOrd1	1	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd1	0,15	-	Dämpfungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
VerstaerkungOrd1	0,0004	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung erster Ordnung des Schlauchs
FrequenzfaktorOrd2	1,8	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd2	0,11	-	Dämpfungsfaktorder nichtlinearen Dämpfung zweiter Ordnung des
VerstaerkungOrd2	0,0002	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung zweiter Ordnung des Schlauchs
FrequenzfaktorOrd3	2,6	-	Verschiebungsfaktor Frequenz zur angegebenen Regression
DaempfungOrd3	0,12	-	Dämpfungsfaktorder nichtlinearen Dämpfung dritter Ordnung des Schlauchs
VerstaerkungOrd3	9,5e-5	mm/bar	Verstärkungsfaktor der nichtlinearen Dämpfung dritter Ordnung des Schlauchs

Bemerkungen

Das Bauteil DEHNSCHLAUCHRESONATORTUNER ist die Zusammenfassung mehrerer verteiltparametrischer Leitungselemente mit dem Ziel, das dynamischen Übertragungsverhalten eines Dehnschlauches mit eingebauten Helmholzresonator abzubilden.

Die Parametrierung erfolgt in einem speziellen Dialog. Die Vorgehensweise zur Parametrierung ist analog zum Bauteil DEHNSCHLAUCH und dort ausführlich beschrieben.



Das Bauteil setzt sich aus einem Einlaufstück und einer Drossel, die als verteiltparametrische Stahlleitungen abgebildet sind, einem Schlauchleitungselement, das die dynamischen Eigenschaften der Schlauchwand berücksichtigt, einem Rohrelement, für die Berücksichtigung der dynamischen Eigenschaften des Tuners sowie einer Tunerbohrung, die ebenfalls als Leitungselement abgebildet ist, zusammen.

Die Berücksichtigung der Gewebewandelastizität entspricht nicht dem physikalischen Aufbau einer Schlauchwand. Die Elastizität wird vielmehr über Ersatzmodelle abgebildet, deren Kennwerte aus dem Vergleich von Messungen und Simulation ermittelt werden müssen.

Die Gesamtparametrierung des Bauteils DEHNSCHLAUCHRESONATORTUNER setzt daher die Kenntnis der Parameter des Gewebestückes *EOelGewebe*, *kviscGewebe* und *dviscGewebe* in erster Näherung voraus. Die Vorgehensweise zur Ermittlung dieser Werte ist im Bauteil Dehnschlauch beschrieben.

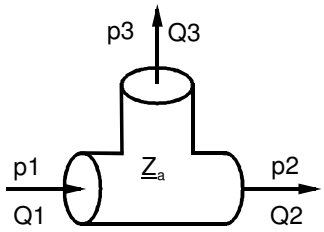
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RohrVerzweigung3fach



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum volumenlosen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
p3	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten

Parameters

Name	Standardwert/ Standardeinheit	Description

Bemerkungen

Das Bauteil ROHRVERZWEIGUNG3FACH ist die widerstandslose Verbindung dreier Knoten, die auf der Modellierung nach dem volumenlosen Ansatz basieren. Das Bauteil dient zur Verknüpfung dreier Rohre. Im Knotenpunkt herrscht folgende Bedingung:

- Der Druck ist im Knotenpunkt der angeschlossenen Leitung gleich:

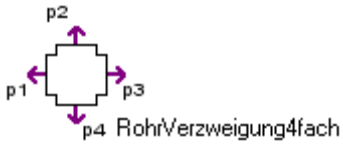
  $p_1 = p_2 = p_3$

- Die Summe der Volumenströme ist Null

  $Q_1 = Q_2 + Q_3 = Q_2 + (1 / Z_a) * p_a$

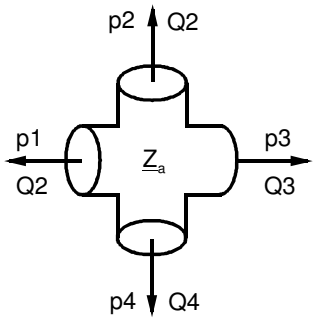
Wobei Z_a die komplexe Eingangsimpedanz der abzweigenden Leitung ist.

RohrVerzweigung4fach



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum volumenlosen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
p3	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten
p4	Hvol	bar	Anschluss Druck 4 zum volumenlosen Knoten

Parameters

Name	Standardwert/ Standardeinheit	Description

Bemerkungen

Das Bauteil ROHRVERZWEIGUNG4FACH ist die widerstandslose Verbindung vierer Knoten, die auf der Modellierung nach dem volumenlosen Ansatz basieren. Das Bauteil dient zur Verknüpfung vierer Rohre. Im Knotenpunkt herrscht folgende Bedingung:

- Der Druck ist im Knotenpunkt der angeschlossenen Leitung gleich:

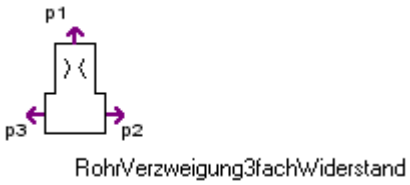
$$p_1 = p_2 = p_3 = p_4$$

- Die Summe der Volumenströme ist Null

$Q_1 = Q_2 + Q_3 + Q_4$

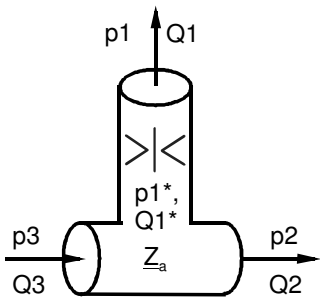
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RohrVerzweigung3fachWiderstand



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum volumenlosen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
p3	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten

Parameters

Name	Standardwert/ Standardeinheit		Description
Volumenstrom	10.	l/min	Volumenstrom durch den Widerstand
Druckdifferenz	5.	bar	Druckdifferenz p1*-p1
WiderstandExponent	0.5		Exponent für die Abhängigkeit von anliegender Druckdifferenz p1*-p1 und Volumenstrom

Bemerkungen

Das Bauteil ROHRVERZWEIGUNG3FACHWIDERSTAND ist die Verknüpfung einer widerstandslosen und widerstandsbehafteten Verbindung dreier Knoten, die auf der Modellierung nach dem volumenlosen Ansatz basieren. Das Bauteil dient zur Verknüpfung dreier Rohre. Im Knotenpunkt herrscht folgende Bedingung:

- Der Druck ist im Knotenpunkt der angeschlossenen Leitung gleich:

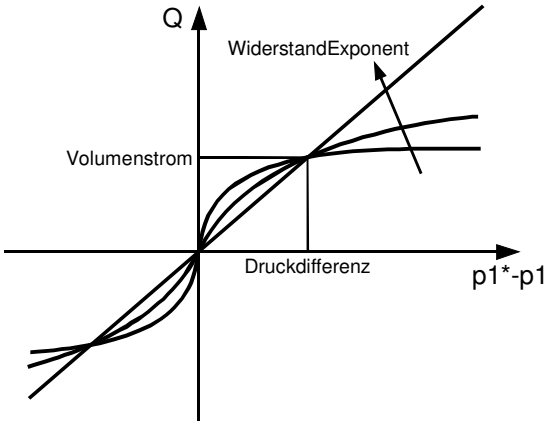
  $p_3 = p_2 = p_{1*}$

- Die Summe der Volumenströme ist Null

  $Q_3 = Q_2 + Q_{1*} = Q_2 + (1 / Z_a) * p_{1*}$

Wobei Z_a die komplexe Eingangsimpedanz der abzweigenden Leitung ist.

Mittels der wiederstandsbehafteten Verbindung p_{1*} nach p_1 können Mischformen zwischen linearer und wurzelförmiger Abhängigkeit der am Bauteil anliegenden Druckdifferenz p_{1*}-p_1 vom Volumenstrom beschrieben werden.



Für lineare Abhängigkeit liegt der WiderstandExponent bei 1, für wurzelförmige Abhängigkeit bei 0,5.

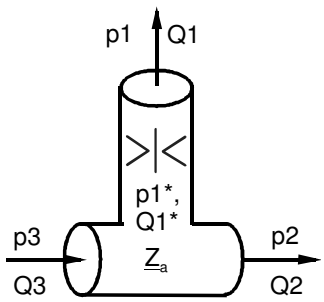
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RohrVerzweigunge3fachWiderstandQp



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum hydraulischen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
p3	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten

Parameters

Name	Standardwert/ Standardeinheit		Description
Volumenstrom	10.	l/min	Volumenstrom durch den Widerstand
Druckdifferenz	5.	bar	Druckdifferenz p1*-p1
WiderstandExponent	0.5		Exponent für die Abhängigkeit von anliegender Druckdifferenz p1*-p1 und Volumenstrom

Bemerkungen

Das Bauteil RohrVerzweigunge3fachWiderstandQp ist die Verknüpfung einer widerstandslosen und widerstandsbehafteten Verbindung zwischen herkömmlichen hydraulischen Knoten und Knoten, die auf der volumenlosen Modellierung basieren.

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Das Bauteil dient zur Verknüpfung dreier Rohre. Im Knotenpunkt herrscht folgende Bedingung:

- Der Druck ist im Knotenpunkt der angeschlossenen Leitung gleich:

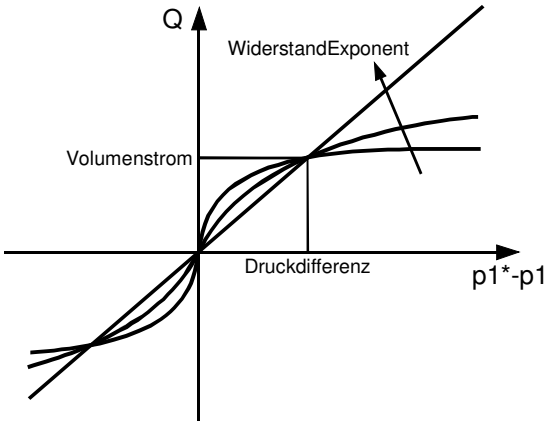
  $P_3 = p_2 = p_{1*}$

- Die Summe der Volumenströme ist Null

  $Q_3 = Q_2 + Q_{1*} = Q_2 + (1 / Z_a) * p_{1*}$

Wobei Z_a die komplexe Eingangsimpedanz der abzweigenden Leitung ist.

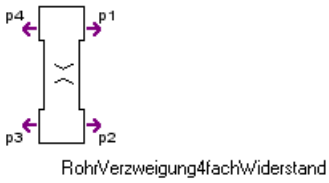
Mittels der wiederstandsbehafteten Verbindung p_{1*} nach p_1 können Mischformen zwischen linearer und wurzelförmiger Abhängigkeit der am Bauteil anliegenden Druckdifferenz p_{1*}-p_1 vom Volumenstrom beschrieben werden.



Für lineare Abhängigkeit liegt der WiderstandExponent bei 1, für wurzelförmige Abhängigkeit bei 0,5.

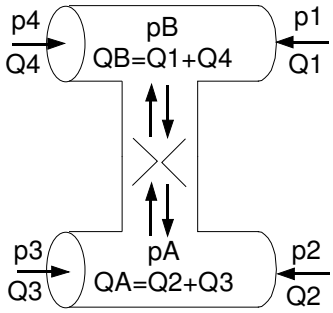
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RohrVerzweigung4fachWiderstand



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum volumenlosen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
p3	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten
p4	Hvol	bar	Anschluss Druck 3 zum volumenlosen Knoten

Parameters

Name	Standardwert/ Standardeinheit		Description
Volumenstrom	10.	l/min	Volumenstrom durch den Widerstand
Druckdifferenz	5.	bar	Druckdifferenz pA-pB
WiderstandExponent	0.5		Exponent für die Abhängigkeit von anliegender *Druckdifferenz* pA-pB und *Volumenstrom*

Bemerkungen

Das Bauteil ROHRVERZWEIGUNG4FACHWIDERSTAND ist die Verknüpfung einer widerstandslosen und widerstandsbehafteten Verbindung von vier Knoten, die auf der Modellierung nach dem volumenlosen Ansatz basieren. Das Bauteil dient zur Verknüpfung von vier Rohren. Im Knotenpunkt herrscht folgende Bedingung:

- Der Druck ist im Knotenpunkt der angeschlossenen Leitung gleich:

  $p_1 = p_4 = p_B$

  $p_2 = p_3 = p_A$

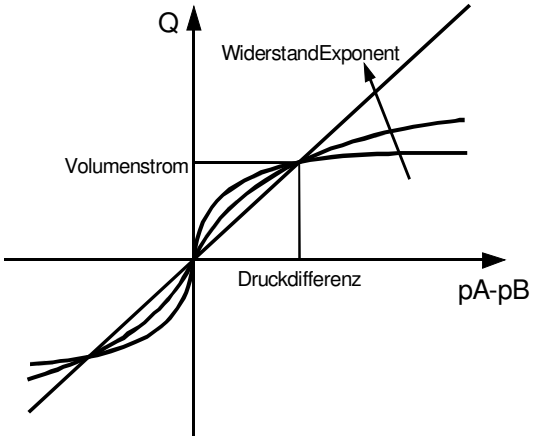
- Die Summe der Volumenströme ist Null

  $Q_A = Q_3 + Q_2$

  $Q_B = Q_4 + Q_1$

  $Q_A = Q_B$

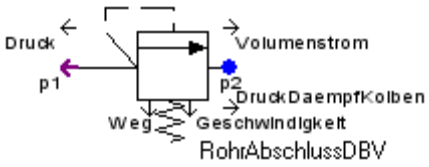
Mittels der wiederstandsbehafteten Verbindung p_A nach p_B können Mischformen zwischen linearer und wurzelförmiger Abhängigkeit der am Bauteil anliegenden Druckdifferenz p_A - p_B vom Volumenstrom beschrieben werden.



Für lineare Abhängigkeit liegt der WiderstandExponent bei 1, für wurzelförmige Abhängigkeit bei 0,5.

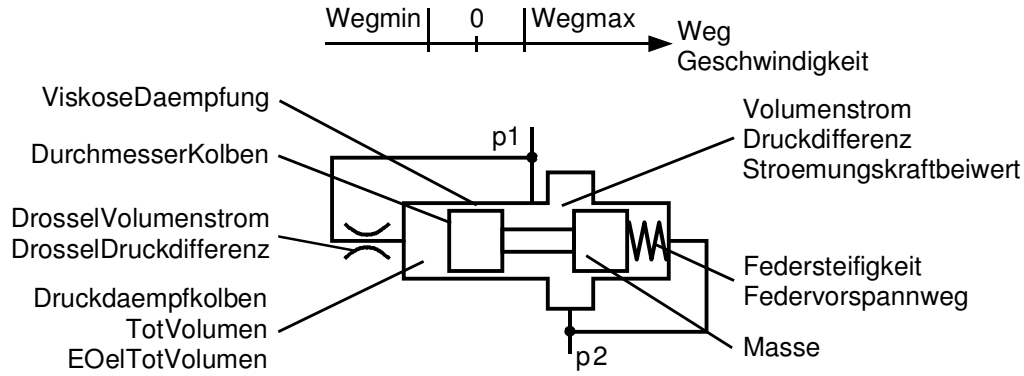
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RohrAbschlussDBV



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	bar	Anschluss Druck 1 zum volumenlosen Knoten
p2	Hvol	bar	Anschluss Druck 2 zum volumenlosen Knoten
Druck	Aus	bar	Druck zum volumenlosen Knoten
DruckDaempfKolben	Aus		Druck hinter der Drossel (interne Hilfsgröße, die zu Kontrollzwecken ausgegeben werden kann)
DruckKolben	V	bar	Startdruck hinter der Drossel
Weg	Aus	mm	Weg des Ventilschiebers (interne Hilfsgröße, die zu Kontrollzwecken ausgegeben werden kann)
Geschwindigkeit	Aus	m/s	Geschwindigkeit des Ventilschiebers (interne Hilfsgröße, die zu Kontrollzwecken ausgegeben werden kann)
Volumenstrom	Aus	l/min	abfließender Volumenstrom

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Parameters

Name	Standardwert/ Standardeinheit		Description
Volumenstrom	30	l/min	Volumenstrom durch das Ventil bei anliegender *Druckdifferenz*
Druckdifferenz	5	bar	s.o.
DrosselVolumenstrom	5	l/min	Volumenstrom durch die Drossel bei anliegender *DrosselDruckdifferenz*
DrosselDruckdifferenz	5	bar	s.o.
Federsteifigkeit	60	N/mm	Steifigkeit der Feder
Federvorspannweg	6.5	mm	Vorspannung der Feder bei *Weg = Wegmin*
Stroemungskraftbeiwert	0	N/mm/ bar	Beiwert für die Strömungskraftberechnung
Wegmax	2	mm	maximaler Schieberweg in positiver Richtung
Wegmin	0	mm	maximaler Schieberweg in negativer Richtung
ViskoseDaempfung	10	Ns/m	geschwindigkeitsabhängige Reibung am Ventilschieber
Masse	0.4	kg	Masse des Schiebers
DurchmesserKolben	5	mm	Durchmesser des Kolbens
TotVolumen	0.1	l	Totvolumen zwischen Drossel und Ventilschieber
EOelTotVolumen	14000	bar	Ersatzkompressionsmodul der Hydraulikflüssigkeit inklusive Wandung bei hohen Drücken im Bereich des *Totvolumens*
Entlastet	0	-	siehe Bemerkungen

Bemerkungen

Das Bauteil RohrAbschlussDBV ist das Modell eines direktgesteuerten Druckbegrenzungsventils, das entsprechend seinen physikalischen Eigenschaften modelliert ist.

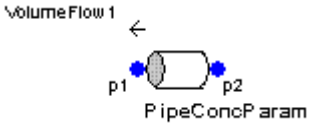
Erreicht die Druckdifferenz *p1 – p2* bzw. *pP* den Öffnungsdruck, öffnet das Ventil, so dass Hydraulikflüssigkeit zum Tank abfließen kann. Der Öffnungsdruck des Ventils wird durch die *Federsteifigkeit* und den *Federvorspannweg* eingestellt.

Ein entlastetes Ventil (*Entlastet = 1*) öffnet, sobald der Versorgungsdruck *pP* größer als der Öffnungsdruck wird (Öffnungsbedingung: *p1* > Öffnungsdruck). Wird ein nicht entlastetes Ventil eingesetzt (*Entlastet = 0*), wirkt sich auch der Druck am Anschluss *p2* auf den Öffnungspunkt aus (Öffnungsbedingung: *p1 – p2* > Öffnungsdruck).

Durch den Parameter *EOelTotVolumen* kann eine zum übrigen System unterschiedliche Bewandung der Leitungen zwischen der Drossel und dem Ventilschieber berücksichtigt werden.

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PipeConcParam



Symbol

Sketch



Connectors and Variables

Name	Typeee	Unit	Description
p1	Hydr	bar	pressure at the *p1* side of the pipe
p2	Hydr	bar	pressure at the *p2* side of the pipe
VolumeFlow	Out	l/min	flow through the pipe

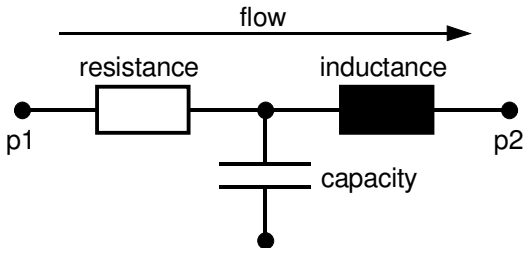
Parameters

Name	Value	Unit	Description
PipeLength	1	m	length of the pipe
PipeDiameter	32	mm	internal diameter of the pipe
AltitudeDifference	0	m	altitude difference between the two ends of the pipe
AccelerationDueToGravity	9.81	m/s^2	gravitational acceleration
TDifference	0	K	Difference between local and system temperaturee

Notes

The component PIPECONCPARAM is the model of a pipeline which represents a tube as a hydraulic inductance and hydraulic resistance. It considers the hydraulic capacity of the tube by the HYDRONODES at the tube ends between which the liquid volume of the tube is divided up automatically (cf., picture).

The friction in the tube is computed flow dependently.



Via the parameters *AltitudeDifference* a difference in levels between the ends of the tube can be considered. Is the connection p2 higher as p1, as is *AltitudeDifference* > 0.

For modeling a tube, several components PIPECONCPARAM must be lined up. The number of the tube components *n* should be chosen as that the length of the tube sections is still less than $^1/_{10}$ of the wavelength of the highest frequency *f* of interest.

If the tube which should be represented has the length *L*,

$$n > 10 \cdot \frac{L \cdot f}{c_0}$$

components PIPECONCPARAM must be lined up. The wave propagation rate c_0 computes

$$c_0 = \sqrt{\frac{E_{\ddot{O}l}'}{\rho}}$$

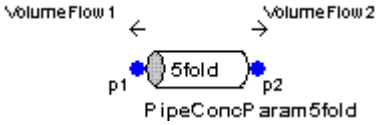
according to the replacement modulus of elasticity $E_{\ddot{o}l}'$ and the density of the fluid ρ.

The number of the sequentially arranged components decides on the accuracy of the model.

For simplification of the model construction and the parametersing, the components PIPECONCPARAM5fold and PIPECONCPARAM10fold which contain five and/or ten sequentially arranged components PIPECONCPARAM can be employed.

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PipeConcParam5fold



Symbol

Sketch



Connectors and Variables

Name	Typeee	Unit	Description
p1	Hydr	bar	pressure at the *p1* side of the pipe
p2	Hydr	bar	pressure at the *p2* side of the pipe
VolumeFlow1	Out	l/min	flow at the *p1* side of the pipe
VolumeFlow2	Out	l/min	flow at the *p2* side of the pipe
Pinternal1	V	bar	internal auxiliary variable
Pinternal2	V	bar	
Pinternal3	V	bar	
Pinternal4	V	bar	
Q1	V	l/min	
Q2	V	l/min	
Qinternal1	V	l/min	
Qinternal2	V	l/min	
Qinternal3	V	l/min	

Parameters

Name	Value	Unit	Description
PipeLength	1	m	total length of the five pipes
PipeDiameter	32	mm	internal diameter of the pipe
TDifference	0	K	Difference between local and system temperaturee
AltitudeDifference	0	m	altitude difference between the two ends of the pipe
AccelerationDueToGravity	9.81	m/s^2	gravitational acceleration

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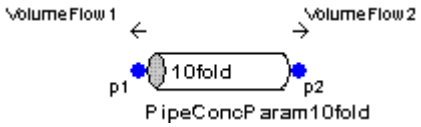
Name	Value	Unit	Description
E_Oil	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to the pressure
ProportionUndissAir	0.8	%	Proportion of unresolved air in the hydraulics liquid
PolytropicExponent	1.1	-	poly tropics exponent for the change of the air volume
Volumechange	0	%	percent change of the volume of the hydraulics liquid at reference pressure (rating for tubing)
PressureRegion	100	bar	reference pressure for the per-cent change of the volume of the hydraulics liquid
Correction	1	-	counter for the correction of the modulus of elasticity (1 with correction, 0 without correction)
p1min	-1	bar	Minimal size of the state variable
Pinternal1min	-1	bar	
Pinternal2min	-1	bar	
Pinternal3min	-1	bar	
Pinternal4min	-1	bar	
p2min	-1	bar	

Notes

The component PIPECONCPARAM5fold contains a concatenation of five identical PIPECONCPARAM components between which in each case a hydraulic knot is (therefore the component Parameters include the parameters of the HYDRONODE). With this component, the model construction and the parametersing can be simplified if a sequence of several PIPECONCPARAM components is necessary.

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PipeConcParam10fold



Symbol

Sketch



Connectors and Variables

Name	Typee	Unit	Description
p1	Hydr	bar	pressure at the *p1* side of the pipe
p2	Hydr	bar	pressure at the *p2* side of the pipe
VolumeFlow1	Out	l/min	flow at the *p1* side of the pipe
VolumeFlow2	Out	l/min	flow at the *p2* side of the pipe
Pinternal1	V	bar	
Pinternal2	V	bar	
Pinternal3	V	bar	
Pinternal4	V	bar	
Pinternal5	V	bar	
Pinternal6	V	bar	
Pinternal7	V	bar	
Pinternal8	V	bar	
Pinternal9	V	bar	
Q1	V	l/min	internal auxiliary variables
Q2	V	l/min	
Qinternal1	V	l/min	
Qinternal2	V	l/min	
Qinternal3	V	l/min	
Qinternal4	V	l/min	
Qinternal5	V	l/min	
Qinternal6	V	l/min	
Qinternal7	V	l/min	
Qinternal8	V	l/min	

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Parameters

Name	Value	Unit	Description
PipeLength	0.1	m	total length of the ten pipes
PipeDiameter	32	mm	internal diameter of the pipe
TDifference	0	K	Difference between local and system temperaturee
AltitudeDifference	0	m	altitude difference between the two ends of the pipe
AccelerationDueToGravity	9.81	m/s^2	gravitational acceleration
E_Oil	14000	bar	bulk modulus of the oil at high pressure including the influence of casing. The bulk modulus is modified due to the pressure
ProportionUndissAir	0.8	%	Proportion of unresolved air in the hydraulics liquid
PolytropicExponent	1.1	-	poly tropics exponent for the change of the air volume
Volumechange	0	%	percent change of the volume of the hydraulics liquid at reference pressure (rating for tubing)
PressureRegion	100	bar	reference pressure for the per-cent change of the volume of the hydraulics liquid
Correction	1	-	counter for the correction of the modulus of elasticity (1 with correction, 0 without correction)
p1min	-1	bar	Minimal size of the state variable
Pinternal1min	-1	bar	
Pinternal2min	-1	bar	
Pinternal3min	-1	bar	
Pinternal4min	-1	bar	
Pinternal5min	-1	bar	
Pinternal6min	-1	bar	
Pinternal7min	-1	bar	
Pinternal8min	-1	bar	
Pinternal9min	-1	bar	
p2min	-1	bar	

Notes

The component PIPECONCPARAM10FOLD contains a concatenation of five identical PIPECONCPARAM components between which in each case a hydraulic knot is (therefore the component Parameters include the parameters of the HYDRONODE). With this component,

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the model construction and the parametersing can be simplified if a sequence of several PIPECONCPARAM components is necessary.

PipeWithFriction



Symbol

Sketch



Connectors and Variables

Name	Typeee	Unit	Description
p1	Hydr	bar	pressure at the *p1* side of the pipe
p2	Hydr	bar	pressure at the *p2* side of the pipe
VolumeFlow1	Out	l/min	flow at the *p1* side of the pipe
VolumeFlow2	Out	l/min	flow at the *p2* side of the pipe

Parameters

Name	Value	Unit	Description
PipeLength	0.1	m	length of the pipe
PipeDiameter	32	mm	internal diameter of the pipe
TDifference	0	K	Difference between local and system temperaturee
E_Oil	14000	bar	compression module of the hydraulic fluid
SimStepSize	1E-5	s	simulation step size
NumberOfElements	10	-	Number of elements into which the pipe is subdivided.

Notes

The component PIPEWITHFRICTION is a model of a pipeline which computes the flow circumstances according to the characteristics procedure.

For this purpose, the tube must be subdivided into elements whose number the accuracy of simulation influences. In the case of a too small number of elements, the component tends towards numeric instability. However, too many elements are not reasonable since the CPU time increases but no higher accuracy can be achieved.

For parametersing the element number, it is recommended to choose one element per meter of tube length, however at least ten.

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The calculation of the tube data is not carried out every simulation step. The simulation increment must be indicated as Paramter (*SimStepSize*) since it is necessary for alignment of tube calculation with calculation of the remaining model.

The component PIPEWITHFRICTION can be inserted only during simulations with unchangeable simulation increment.

HoseConcParam



Symbol

Sketch



Connectors and Variables

Name	Typee	Unit	Description
p1	Hydr	bar	pressure at pipe end 1
p2	Hydr	bar	pressure at pipe end 2
Volumeflow1	Out	l/min	flow at pipe end 1
Volumeflow2	Out	l/min	flow at pipe end 2

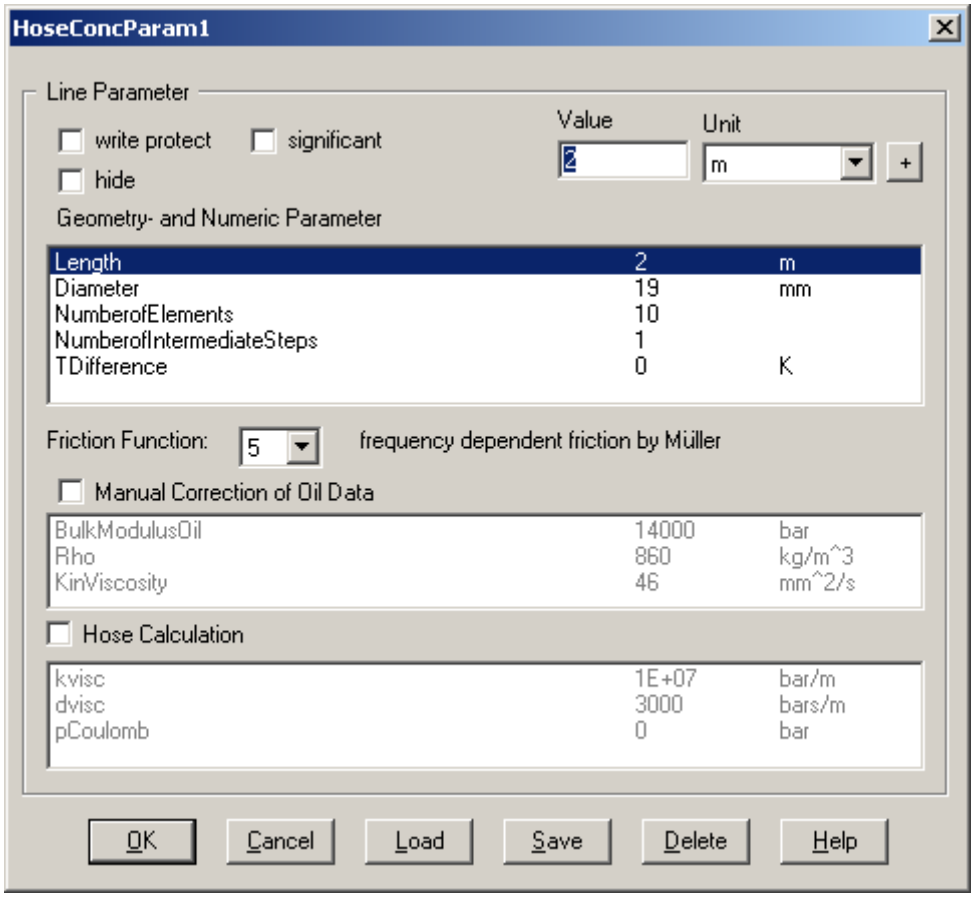
Parameters

Name	Value	Unit	Description
Length	2.	m	complete length of the pipe
Diameter	19.	mm	inner diameter
NumberofElements	10.	-	number of the elements, in which the pipe is separated
NumberofIntermediat-eSteps	1.	-	gear reduction to central simula-tion distance/space
TDifference	0	K	Difference between local and system temperature
Friction Function	0		kind of the friction description
BulkModulusOil	14000	bar	compression module of hydraulic liquid
Rho	860	kg/m³	Fluid density
KinViscosity	46	mm²/s	kinematical viscosity of the fluid
Kvisc	1E+7	bar/m	factor for the tube calculation
Dvisc	3000	bars/m	factor for the tube calculation
PCoulomb	0.	bar	factor for the tube calculation

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Notes

The component HoseConcParam is the model of a pipeline which represents a pipe resp. a tube as a hydraulic inductance and hydraulic resistance. The parameterization happens in a special dialogue.



The input of the geometry and the choice of the frequency dependant friction calculation occurs in the upper area of the dialog.

The parameter *NumberofElements* determines into how many single capacities the pipeline has to be separated. The pipeline closed up with an inductance at each end.

The number *n* of the pipeline elements should be chosen in the way, that the pipe sections are smaller than $^1/_{10}$ to the wavelength of the highest interesting frequency *f*.

If the tube which should be represented has the length *L*,

$$n > 10 \cdot \frac{L \cdot f}{c_0}$$

components PipeConcParam must be lined up. The wave propagation rate c_0 computes

$$c_0 = \sqrt{\frac{E_{\ddot{O}l}'}{\rho}}$$

according to the replacement modulus of elasticity $E_{\ddot{o}l}'$ and the density of the fluid ρ.

The number of the sequentially arranged components decides on the accuracy of the model.

The parameter *NumberofIntermediateSteps* determines if the pipeline is calculated with the central calculation step distance/space or if a gear reduction of the calculation f. e. like it is advantageous with higher frequencies in the pipeline.

The parameter *TDifference* represents the temperature difference from local to global system temperature.

The friction in the tube is computed flow dependently and increased by a frequency dependently part. The parameter *Friction Funtion* determines which friction start is appropriated.

0 = quasi static Calculation

1 = frequency dependently friction by Theissen [very fast]

2 = frequency dependently friction by Taylor

3 = frequency dependently friction by Stoffel

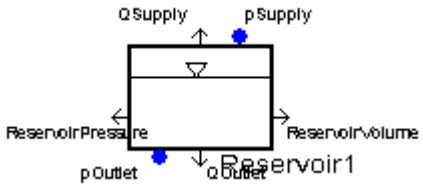
4 = frequency dependently friction by Kitagawa [very exactly]

5 = frequency dependently friction by Müller [well compromise]

The parameter *Hosecalculation* defines if during the calculation the elasticity of the tube wall is considered. The coefficients are possibly can be investigated throughout the measurements of the pipelines by Müller.

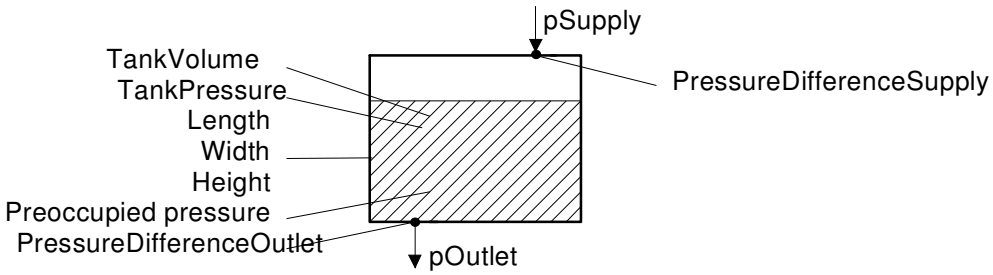
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Reservoir



Symbol

Sketch



Connectors and Variables

Name	Typee	Unit	Description
Qsupply	Out	l/min	Supply volumeflow
Qoutlet	Out	l/min	Outlet volumeflow
pSupply	Hydr	bar	Supply Pressure
pOutlet	Hydr	bar	Outlet Pressure
ReservoirPressure	Out	bar	Pressure in the Reservoir
ReservoirVolume	Out	Bar	Volume in the Reservoir

Parameters

Name	Value	Unit	Description
Height	0.3	M	Height of the reservoir
Width	0.5	M	Width of the reservoir
Depth	0.3	M	Depth of the reservoir
ChargingPressure	0	bar	
VolumeFlow	100	l/min	Volumeflow of the reservoir
PressureDifferenceSupply	0.005	Bar	Supply pressure difference
PressureDifferecneOutlet	0.01	bar	Pressure difference at the outlet

Notes

The component RESERVOIR is the model of a fluid container, which is described by the geometrical parameters height, width and depth and with hydraulic parameter. The RESERVOIR exit and the RESERVOIR entrance represent combination of OrificeThrottle resis-

tances, which are described with the hydraulic characteristic values flow rate, preload pressure, difference of pressure in inlet and outlet.

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PipeDistributedParam



Symbol

Sketch



Connectors and Variables

Name	Typee	Unit	Description
p1	Hvol	-	connector to the volume less node
p2	Hvol	-	connector to the volume less node

Parameters

Name	Value	Unit	Description
Length	2.	m	complete length of the pipe
Diameter	19.	mm	inner diameter
IncrementProportion	1	-	gear reduction to central simulation distance/space
Qmax	100	l/min	maximum expected flow
epsilonGradient	1000.	-	factor to the interpolation of the gradient of the characteristics
Tdifference	0	K	Difference between local and system temperature
Correction	0	-	Correction factor
BulkModulusOil	14000	bar	Bulkmodulus of the hydraulic oil
Rho	860	Kg/m³	Density of the hydraulic oil
KinViscosity	46	mm²/s	Kinematic viscosity of the oil
FrictionCalculation	5	-	kind of the friction description
E_Oil	14000	bar	compression module of hydraulic liquid
kvisc	1.E7	bar/m	factor for the tube calculation
dvisc	3000	bars/m	factor for the tube calculation

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Notes

The component PIPEDISTRIBUTEDPARAM is the model of a pipeline which calculates the flow rates by the characteristic-method. The pipe is separated into sections, its number influences the precision of the simulation.The number of the used elements is determined automatically by the parameter *Qmax* , which represents the maximum circulating flow in the pipe during the simulation.

A high value for *Qmax* brings about a small number of elements, because of this the component inclines to a numerically damping. Too many elements are not rational, because the calculation time arises but no better precision will be reached.

The parameter *IncrementProportion* determines if the pipeline is calculated with the central calculation step distance/space or if a gear reduction of the calculation f. e. like it is advantageous with higher frequencies in the pipeline.

The friction in the tube is computed flow dependently and increased by a frequency dependently part. The parameter *FrictionCalculation* determines which friction method is appropriated.

0 = quasi static Calculation

1 = frequency dependently friction by Theissen [very fast]

2 = frequency dependently friction by Taylor

3 = frequency dependently friction by Stoffel

4 = frequency dependently friction by Kitagawa [very exactly]

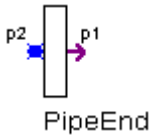
5 = frequency dependently friction by Müller [well compromise]

Through the parameter *EpsilonGradient* the interpolation of the gradient is able to be influenced in the calculation of the characteristics. Thereby theoretical a further improvement of the calculation exactness can be reached. Examinations of Müller show no fundamental/essential change of the results of the typical frequencies for hydraulic systems by using the *EpsilonGradient.* The standard value 1000 extremely reduced the influence of the interpolation, so it is more or less deactivated. Using values lees than 10000 the interpolation works.

Models with distributed pipe components requires coercively the termination with the component PIPEENDQIN.

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PipeEnd



Symbol

Sketch

Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	-	Connector to volume less node
p2	Hydr	bar	Pressure in the node in front of the component

Parameters

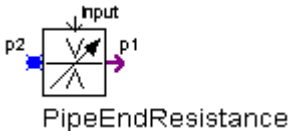
Name	Value	Unit	Description
-	-	-	-

Notes

The component PIPEEND is a resistanceless cut between common hydraulic nodes and nodes, which base on volumenless modeling.

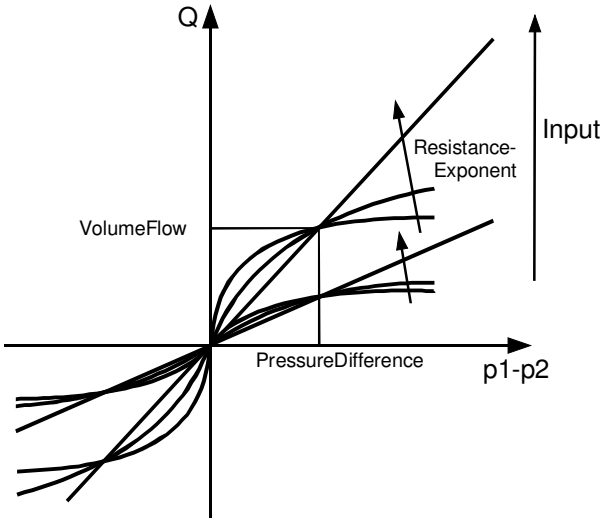
As a kind of resistance marked cut between common hydraulic nodes and volume less nodes the component PIPEENDRESISTANCE is available.

PipeEndResistance



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	-	Connector to volume less node
p2	Hydr	bar	Pressure in the node in front of the component Pressure im Node vor dem Component
Input	In	-	Inputssignal to the adjustment

Parameters

Name	Value	Unit	Description
Volumeflow	10.	l/min	Flow through the resistance at *PressureDifference* and *Input-Max*
Pressuredifference	5.	bar	s.o.
ResistanceExponent	0.5	-	Exponent to the dependence of adjacent PressureDifference *p1-p2* and *Flow*
InputMax	1.	-	maximum Inputssignal

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Notes

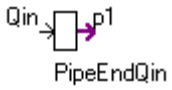
The component PIPEENDRESISTANCE is a resistance marked cut between common n hydraulic nodes and nodes, which base on volume less modeling.

This component can be used to describe mixed forms between linear and root shaped dependence of the *PressuredDifference p1 - p2* to *Volumeflow* adjacent to the component. For linear dependence the *ResistanceExponent* is *1*, for root shaped dependence it is *0,5*.

The relation of *Volumeflow* to *PressureDifference p1-p2* is able to be regulated by the inputssignal.

As resistance less cut between common and volume less node conduces the component PIPEEND.

PipeEndQIn



Symbol

Sketch

Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	-	Connector to volume less node
QIn	In	-	Signal input to default a flow

Parameters

Name	Value	Unit	Description
-	-	-	-

Notes

The component PipeEndQIn is a resistance less cut node, (between common hydraulic nodes and nodes) which base on volume less modeling.

With a function generator.a volume less flow can be inserted into the volume less node through the input *QIn*.

Models with distributed pipe components requires coercively the termination with the component PIPEENDQIN.

As resistance less cut between common and volume less node conduces the component PIPEEND.

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PipeConnection



Symbol

Sketch

Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	-	Connector to volume less node
p2	Hvol	-	Connector to volume less node

Parameters

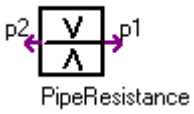
Name	Value	Unit	Description
-	-	-	-

Notes

The component PIPECONNECTION is the resistanceless connection of two nodes, which base on the modeling after the volume less start.

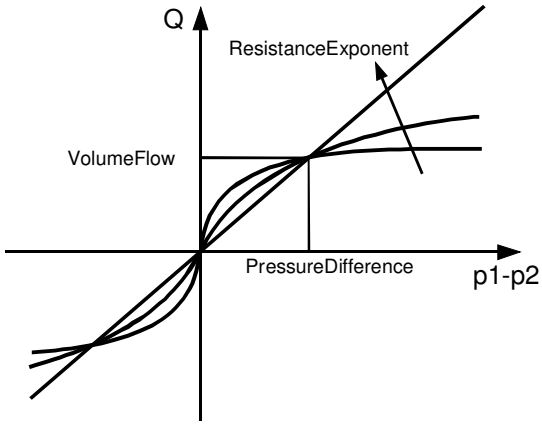
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PipeResistance



Symbol

Sketch



Connectors and Variables

Name	Type	Unit	Description
p1	Hvol	-	Connector to volume less node
p2	Hvol	-	Connector to volume less node

Parameters

Name	Value	Unit	Description
Volumeflow	10	l/min	Flow through the resistance at *PressureDifference*
Pressuredifference	5	bar	s.o.
ResistanceExponent	0.5	-	Exponent to the dependence of adjacent PressureDifference *p1-p2* and *Flow*

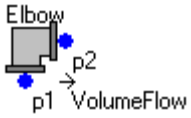
Notes

The component PIPERESISTANCE is the resistance marked connection of two nodes, which base on the modeling after the volume less start.

This component can be used to describe mixed forms between linear and root shaped dependence of the *PressuredDifference p1 - p2* to *Flow* adjacent to the component. For linear dependence the *ResistanceExponent* is *1*, for root shaped dependence it is *0,5*.

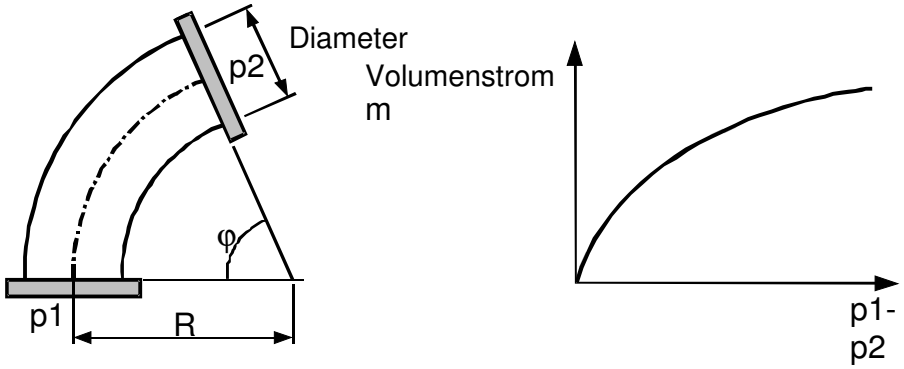
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Elbow



Symbol

Sketch



Connectors and Variables

Name	Typee	Unit	Description
p1	Hydr	bar	pressure at side *p1* of the elbow
p2	Hydr	bar	pressure at side *p2* of the elbow
VolumeFlow	Out	l/min	flow through the elbow

Parameters

Name	Value	Unit	Description
LossFactor	0.5	-	cf., tables mentioned below
TDifference	0	K	Difference between local and system temperaturee
Diameter	10	mm	diameter of the elbow

Notes

The component ELBOW was modeled in order to be able to consider precisely the losses of pressure in hydraulic systems with many pipelines. However, the use of the component can lead to extremely long simulation times since one must choose a small simulation increment because of the small resistance of an Elbow.

The Pressure loss $\Delta p_V = p_1 - p_2$ in a bend itself is computed according to the formula

$$\Delta p_V = \zeta \rho \frac{v^2}{2},$$

where ζ designates the parameters resistance coefficient, v the flow velocity and ρ the parameters Rho .

In the following tables, standard values are given for the resistance coefficient z. In this case, it is distinguished between bends (without marked radius of curvature R) and elbows(with considerable radius of curvature R) where circular sectional views always be assumed:

Bend

For bends with distinct radius of curvature R the resistance coefficient ζ changes depending on the curve angle φ according to the formula:

$$\zeta = k\ \zeta_{90deg}$$

Out of the following table the values for ζ_{90deg} depending on the ratio radius of curvature R to tube diameter d can be read off. The second table specifies values for the factor k depending on the radius of curvature φ (where appropriate interpolation is necessary).

R/d	1	2	4	6	10
ζ_{90deg}	0,21	0,14	0,11	0,09	0,11

φ	30deg	60deg	90deg	120deg	150deg	180deg
k	0,4	0,7	1,0	1,25	1,5	1,7

At multiple bends, the following equations can give clues for the calculation of ζ :

Double bend (two bends arranged semicircular): $\zeta_{double} = 2\ \zeta_{single}$

Room crooked (two bends arranged angular to each other):

$\zeta_{Room} = 3\ \zeta_{single}$

Floor crooked (two bends arranged p-shaped):

$\zeta_{Floor} = 4\ \zeta_{single}$

Elbow

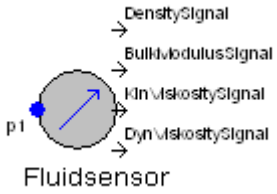
Crank for bends without marked radius of curvature R, ζ can be taken out of the following table and/or can be computed by interpolation:

φ	22,5deg	30deg	45deg	60deg	90deg
ζ	0,07	0,1	0,24	0,47	1,13

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Miscellaneous

Fluidsensor



Symbol

Sketch

Connectors und Variables

Name	Type	Unit	Description
p1	Hydr	bar	connector to the node
DensitySignal	Out	kg/m³	density output
BulkModulusSignal	Out	bar	bulk modulus outpput
kinViskositySignal	Out	mm²/s	output of kinematic viskosity
dynViskositySignal	Out	Pas	output of dynamic viskosity

Parameters

Name	Value	Unit	Description
BulkModulusCorrection	1	0 No, 1 Yes	Output of the Bulk-Modulus with regard of the undissolved air

Notes

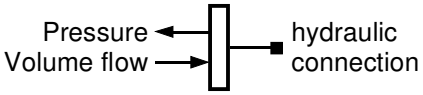
The component FLUIDSENSOR is a component, through which the fluid properties (density, bulk modulus, viscosities) of the connected node are tapped out as signal values.

Hydro2Signal



Symbol

Sketch



Connectors und Variables

Name	Type	Unit	Description
pA	Hydr	bar	connector to the node
Pressure	Out		Pressure signal connector
Q	In		Flow connector

Parameters

Name	Value	Unit	Description
-	-	-	-

Notes

The component HYDRO2SIGNAL is a component, through which the pressure of the connected node is tapped out as a signal value and an external flow can be entered into the system.

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