Valve43

In[387]:=
```
<< C:\\Hopsan\Compgen\CompgenNG.mx
```

This path is pointing to where the file should be generated

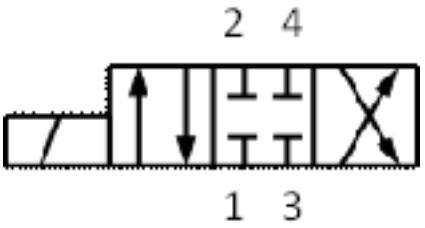
```
path = ToFileName[{"H:", "PettersDropbox", "Dropbox",
     "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}];

path = ToFileName[{"C:", "Users", "petkr14", "Dropbox",
     "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}];
```

In[390]:=
```
domain = "Pneumatic";
displayName = "Valve43";
brief = "Pneumatic 43-valve";
componentType = "ComponentQ";
author = "Petter Krus <petter.krus@liu.se>";
affiliation = "Division of Fluid and Mechatronic Systems, Linköping University";
SetFilenames[path, domain, displayName];
ResetComponentVariables[];
Date[]
```

Component description

This is a simple pneumatic valve with three ports and three positions. It is closes all flow paths when the input signal is zero and opens between pressure port (1) and load port (2) and between the load port (4) and return (3) when it is one. The opening is proportional to the input signal. At negative signals it opens the load port (2) to the return port (3) and between the pressure port (1) and load port (4). The opening is proportional to the input signal. There is no valve dynamics



In[400]:=
```
inputParameters = {
    {Cd, 0.65, double, "", "Discharge coefficient"},
    {R, 287., double, "J/Kg K", "Gas constant"},
    {cv, 718, double, "J/Kg K", "heatcoeff"},
    {eps, 0.02, double, "", "Linearisation coeff"},
    {x0, 0.1, double, "", "Relative overlap"},
    {A1max, 1. * 10^-5, double, "m2", "Max opening area"},
    {A3max, 1. * 10^-5, double, "m2", "Max opening area"}
   };
```

In[401]:=
```
inputVariables = {
    {xin, 1, double, "", "Input signal 0<xin<1"}
   };
```

```
outputVariables = {
    {qm12Pos, 0., double, "kg/s", "Internal variable"},
    {qm12Neg, 0., double, "kg/s", "Internal variable"},
    {qm32Pos, 0., double, "kg/s", "Internal variable"},
    {qm32Neg, 0., double, "kg/s", "Internal variable"},
    {qm14Pos, 0., double, "kg/s", "Internal variable"},
    {qm14Neg, 0., double, "kg/s", "Internal variable"},
    {qm34Pos, 0., double, "kg/s", "Internal variable"},
    {qm34Neg, 0., double, "kg/s", "Internal variable"},
    {Ng32e, 0., double, "", "Internal variable"},
    {Ng12e, 0., double, "", "Internal variable"},
    {Ng34e, 0., double, "", "Internal variable"},
    {Ng14e, 0., double, "", "Internal variable"}
  };
```

In[403]:=
```
nodeConnections = {
    PneumaticQnode[1, 100000., "fluid port 1 (P)"],
    PneumaticQnode[2, 100000., "fluid port 2 (A)"],
    PneumaticQnode[3, 100000., "fluid port 3 (R)"],
    PneumaticQnode[4, 100000., "fluid port 4 (B)"]
  };
```

The system of equations

The spool position is recalculated.

In[404]:=
```
xine = xin;
```

The valve areas are limited between 0 and A1max and A3max respectively .

In[405]:=
```
A12 = A1max limit[(xine - x0)/(1 - x0), 0, 1];
A32 = A3max limit[(-xine - x0)/(1 - x0), 0, 1];
A14 = A1max limit[(-xine - x0)/(1 - x0), 0, 1];
A34 = A3max limit[(xine - x0)/(1 - x0), 0, 1];
```

Calculation of the Ng functions for flow calculations.

In[409]:=
```
Ng1 = 1;
```

In[410]:=
$$\texttt{Ng12pos} = \left(\texttt{signedSquareL}\left[\frac{\left(\frac{p2}{p1}\right)^{2/\text{kappa}} - \left(\frac{p2}{p1}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[411]:=
$$\texttt{Ng12neg} = \left(\texttt{signedSquareL}\left[\frac{\left(\frac{p1}{p2}\right)^{2/\text{kappa}} - \left(\frac{p1}{p2}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[412]:=
$$\texttt{Ng12} := \texttt{onPositive}[p1 - p2]\left(\texttt{onPositive}\left[\frac{p2}{p1} - \text{crit}\right]\texttt{Ng12pos} + \texttt{onNegative}\left[\frac{p2}{p1} - \text{crit}\right]\texttt{Ng1}\right) +$$
$$\texttt{onNegative}[p1 - p2]\left(\texttt{onPositive}\left[\frac{p1}{p2} - \text{crit}\right]\texttt{Ng12neg} + \texttt{onNegative}\left[\frac{p1}{p2} - \text{crit}\right]\texttt{Ng1}\right);$$

In[413]:=
$$\text{Ng32pos} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p2}}{\text{p3}}\right)^{2/\text{kappa}} - \left(\frac{\text{p2}}{\text{p3}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[414]:=
$$\text{Ng32neg} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p3}}{\text{p2}}\right)^{2/\text{kappa}} - \left(\frac{\text{p3}}{\text{p2}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[415]:=
$$\text{Ng32} := \text{onPositive}[\text{p3} - \text{p2}]\left(\text{onPositive}\left[\frac{\text{p2}}{\text{p3}} - \text{crit}\right]\text{Ng32pos} + \text{onNegative}\left[\frac{\text{p2}}{\text{p3}} - \text{crit}\right]\text{Ng1}\right) + \text{onNegative}[\text{p3} - \text{p2}]\left(\text{onPositive}\left[\frac{\text{p3}}{\text{p2}} - \text{crit}\right]\text{Ng32neg} + \text{onNegative}\left[\frac{\text{p3}}{\text{p2}} - \text{crit}\right]\text{Ng1}\right);$$

In[416]:=
$$\text{Ng14pos} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p4}}{\text{p1}}\right)^{2/\text{kappa}} - \left(\frac{\text{p4}}{\text{p1}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[417]:=
$$\text{Ng14neg} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p1}}{\text{p4}}\right)^{2/\text{kappa}} - \left(\frac{\text{p1}}{\text{p4}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[418]:=
$$\text{Ng14} := \text{onPositive}[\text{p1} - \text{p4}]\left(\text{onPositive}\left[\frac{\text{p4}}{\text{p1}} - \text{crit}\right]\text{Ng14pos} + \text{onNegative}\left[\frac{\text{p4}}{\text{p1}} - \text{crit}\right]\text{Ng1}\right) + \text{onNegative}[\text{p1} - \text{p4}]\left(\text{onPositive}\left[\frac{\text{p1}}{\text{p4}} - \text{crit}\right]\text{Ng14neg} + \text{onNegative}\left[\frac{\text{p1}}{\text{p4}} - \text{crit}\right]\text{Ng1}\right);$$

In[419]:=
$$\text{Ng34pos} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p4}}{\text{p3}}\right)^{2/\text{kappa}} - \left(\frac{\text{p4}}{\text{p3}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[420]:=
$$\text{Ng34neg} = \left(\text{signedSquareL}\left[\frac{\left(\frac{\text{p3}}{\text{p4}}\right)^{2/\text{kappa}} - \left(\frac{\text{p3}}{\text{p4}}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[421]:=
$$\text{Ng34} := \text{onPositive}[\text{p3} - \text{p4}]\left(\text{onPositive}\left[\frac{\text{p4}}{\text{p3}} - \text{crit}\right]\text{Ng34pos} + \text{onNegative}\left[\frac{\text{p4}}{\text{p3}} - \text{crit}\right]\text{Ng1}\right) + \text{onNegative}[\text{p3} - \text{p4}]\left(\text{onPositive}\left[\frac{\text{p3}}{\text{p4}} - \text{crit}\right]\text{Ng34neg} + \text{onNegative}\left[\frac{\text{p3}}{\text{p4}} - \text{crit}\right]\text{Ng1}\right);$$

Equations

In[422]:=
```
localExpressions = {
    kappa == 1 + R/cv,
    Kg == Sqrt[2^((kappa+1)/(kappa-1)) kappa (1/(kappa+1))^((kappa+1)/(kappa-1)) / R],
    Ndenom == 2^((kappa+1)/(kappa-1) - 1) (kappa - 1) (1/(kappa + 1))^((kappa+1)/(kappa-1)),
    crit == 2^(kappa/(kappa-1)) (1/(kappa + 1))^(kappa/(kappa-1)),
    cp == cv + R
  };
```

Expressions for enthalpy flows and mass flows.

In[423]:=
```
dE12 = qm12 cp (onNegative[qm12] T2 + onPositive[qm12] T1);
dE32 = qm32 cp (onNegative[qm32] T2 + onPositive[qm32] T3);
dE14 = qm14 cp (onNegative[qm14] T4 + onPositive[qm14] T1);
dE34 = qm34 cp (onNegative[qm34] T4 + onPositive[qm34] T3);

qm12 = (onPositive[p1 - p2] qm12Pos - onNegative[p1 - p2] qm12Neg);
qm32 = (onPositive[p3 - p2] qm32Pos - onNegative[p3 - p2] qm32Neg);
qm14 = (onPositive[p1 - p4] qm14Pos - onNegative[p1 - p4] qm14Neg);
qm34 = (onPositive[p3 - p4] qm34Pos - onNegative[p3 - p4] qm34Neg);
```

The system equations to be solved in each time step

In[431]:=
```
systemEquationsDA = Simplify[{
    qm12Pos == p1 Cd A12 Kg Ng12 / Sqrt[T1],
    qm12Neg == p2 Cd A12 Kg Ng12 / Sqrt[T2],
    qm32Pos == p3 Cd A32 Kg Ng32 / Sqrt[T3],
    qm32Neg == p2 Cd A32 Kg Ng32 / Sqrt[T2],
    qm14Pos == p1 Cd A14 Kg Ng14 / Sqrt[T1],
    qm14Neg == p4 Cd A14 Kg Ng14 / Sqrt[T4],
    qm34Pos == p3 Cd A34 Kg Ng34 / Sqrt[T3],
    qm34Neg == p4 Cd A34 Kg Ng34 / Sqrt[T4],
    dE2 == dE12 + dE32,
    dE4 == dE14 + dE34,
    dE1 == -dE12 - dE14,
    dE3 == -dE32 - dE34
    }];
```

Boundaries

The boundary equations for transmission line ports

In[432]:=
```
systemBoundaryEquations = {
   p2 == (c2 + Zc2 dE2),
   p4 == (c4 + Zc4 dE4),
   p1 == (c1 + Zc1 dE1),
   p3 == (c3 + Zc3 dE3)
  };
```

Independent Variables

In[433]:=
```
systemVariables = {qm12Pos, qm12Neg, qm32Pos, qm32Neg,
   qm14Pos, qm14Neg, qm34Pos, qm34Neg, dE2, dE4, dE1, dE3, p2, p4, p1, p3};
```

Expressions

Variables are calculated that are not directly involved in the system equations. The inlet flow is calculated as the outlet flow with reversed sign.

```
expressions = {
   qm1 == -qm12 - qm14,
   qm2 == qm12 + qm32,
   qm3 == -qm32 - qm34,
   qm4 == qm14 + qm34,
   Ng32e == Ng32,
   Ng12e == Ng12,
   Ng34e == Ng34,
   Ng14e == Ng14
 };
```

In[435]:=
```
Compgen[file]
```