# Simulink Report: Node_3D_

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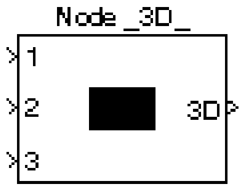
# Model - Node_3D_



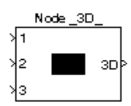

### Tabelle 1.1. Node_3D_ Simulation Parameters

| | | |
|---|---|---|
| *Solver* ode14x | *ZeroCross* on | *StartTime* 0.0*StopTime* 10.0 |
| *RelTol* 1e-3 | *AbsTol* auto | *Refine* 1 |
| *InitialStep* auto | *FixedStep* auto | *MaxStep* auto |

### Tabelle 1.2. Node_3D_ Summary Information

| | | | |
|---|---|---|---|
| *NumModelInputs* | N/A | *NumModelOutputs* | N/A |
| *NumVirtualSubsystems* | N/A | *NumNonvirtSubsystems* | N/A |
| *NumNonVirtBlocksInModel* | N/A | *NumBlockTypeCounts* | N/A |
| *NumBlockSignals* | N/A | *NumBlockParams* | N/A |
| *NumZCEvents* | N/A | *NumNonsampledZCs* | N/A |

# Systems

| **Name** | **Parent** | **Snapshot** | **Blocks** | **Signals** |
|---|---|---|---|---|
| Node_3D_ | <root> |  | Node_3D_ | Node_3D_<1> |

# Blocks

### Tabelle 1.3. Block Type Count

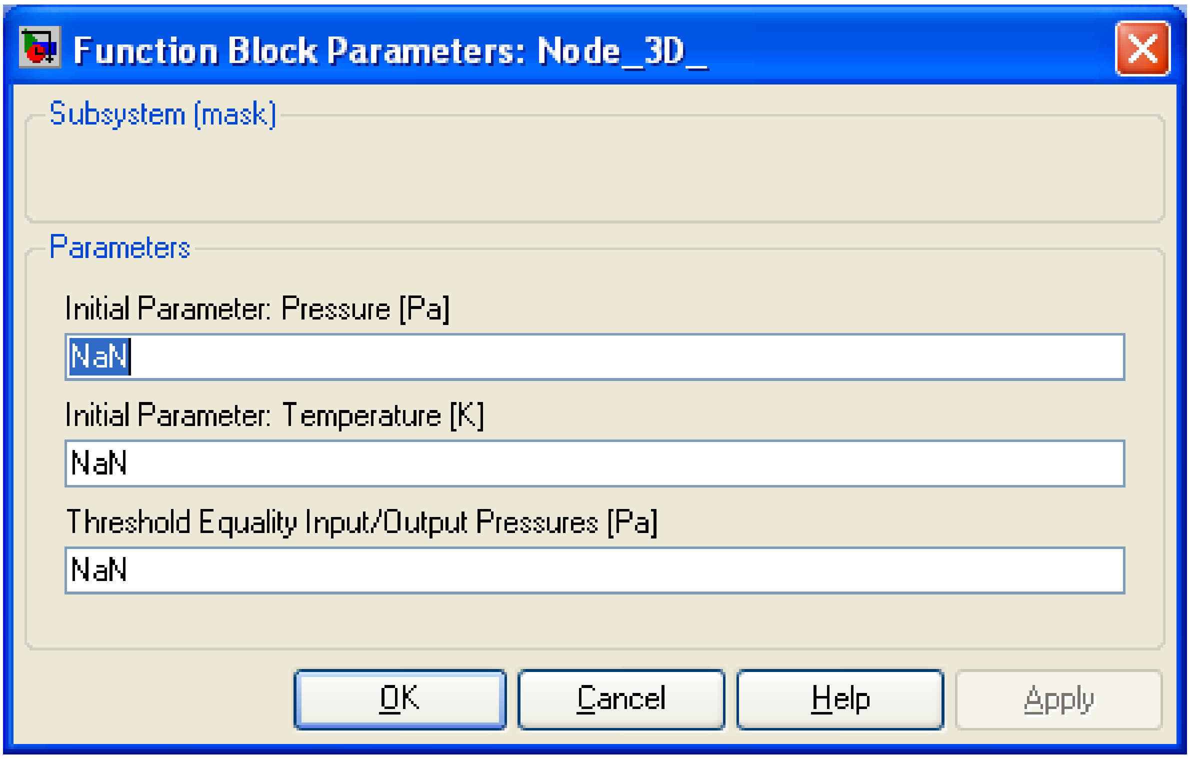
| **BlockType** | **Count** | **Block Names** |
|---|---|---|
| Inport | 31 | In_1, In_2, In_3, p_old, rho_old, T_old, x_H2O_gas_old, x_CO2_old, x_H2O_liq_old, p_in_1, rho_in_1, T_in_1, m_dot_air_in_1, x_H2O_gas_in_1, x_CO2_in_1, x_H2O_liq_in_1, p_in_2, rho_in_2, T_in_2, m_dot_air_in_2, x_H2O_gas_in_2, x_CO2_in_2, x_H2O_liq_in_2, p_in_3, rho_in_3, T_in_3, m_dot_air_in_3, x_H2O_gas_in_3, x_CO2_in_3, x_H2O_liq_in_3, Delta_p_threshold |

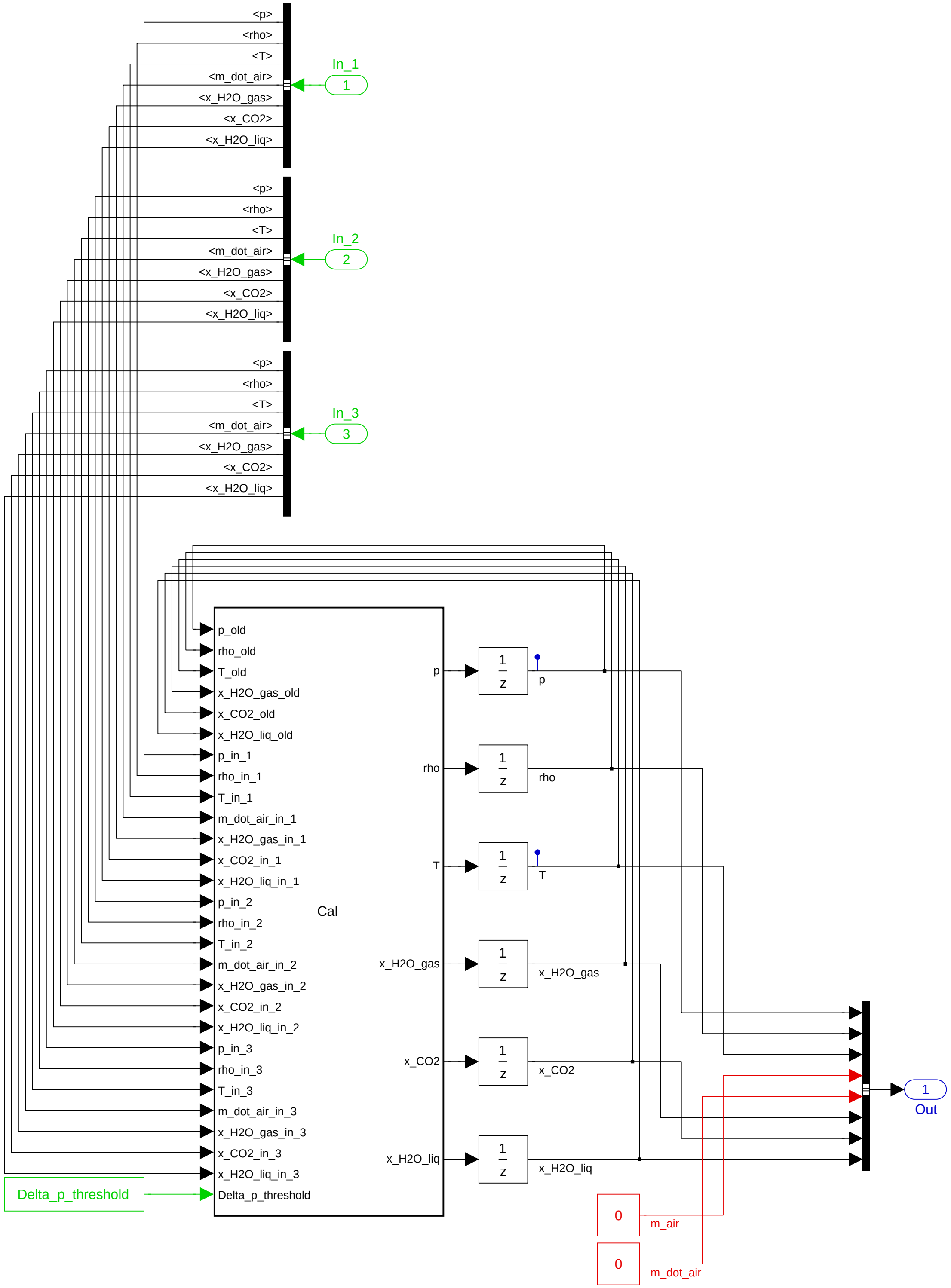
| BlockType | Count | Block Names |
|---|---|---|
| Outport | 7 | p, rho, T, x_H2O_gas, x_CO2, x_H2O_liq, Out |
| UnitDelay | 6 | Unit Delay, Unit Delay1, Unit Delay2, Unit Delay3, Unit Delay4, Unit Delay5 |
| Constant | 3 | Delta_p_threshold, m_air, m_dot_air |
| BusSelector | 3 | Bus Selector1, Bus Selector2, Bus Selector4 |
| Terminator | 1 | Terminator |
| SubSystem | 1 | Node_3D_ |
| Stateflow (m) | 1 | Embedded_MATLAB_Function |
| S-Function | 1 | SFunction |
| Demux | 1 | Demux |
| BusCreator | 1 | Bus Creator1 |

# Data and Functions

### Tabelle 1.4. Model Functions

| Function Name | Parent Blocks | Calling string |
|---|---|---|
| NaN | Node_3D_<br>Node_3D_<br>Node_3D_ | `NaN`<br>`NaN`<br>`NaN` |


Function Block Parameters: Node_3D_
Subsystem (mask)
Parameters
Initial Parameter: Pressure [Pa]
NaN
Initial Parameter: Temperature [K]
NaN
Threshold Equality Input/Output Pressures [Pa]
NaN
OK
Cancel
Help
Apply



<p>
<rho>
<T>
<m_dot_air>
<x_H2O_gas>
<x_CO2>
<x_H2O_liq>
In_1
1
In_2
2
In_3
3
p_old
rho_old
T_old
x_H2O_gas_old
x_CO2_old
x_H2O_liq_old
p_in_1
rho_in_1
T_in_1
m_dot_air_in_1
x_H2O_gas_in_1
x_CO2_in_1
x_H2O_liq_in_1
p_in_2
rho_in_2
T_in_2
m_dot_air_in_2
x_H2O_gas_in_2
x_CO2_in_2
x_H2O_liq_in_2
p_in_3
rho_in_3
T_in_3
m_dot_air_in_3
x_H2O_gas_in_3
x_CO2_in_3
x_H2O_liq_in_3
Delta_p_threshold
Cal
p
rho
T
x_H2O_gas
x_CO2
x_H2O_liq
1/z
0
m_air
0
m_dot_air
1
Out

```
function [p,rho,T,x_H2O_gas,x_CO2,x_H2O_liq] = Cal(p_old,rho_old,T_old,x_H2O_gas_old,↙
x_CO2_old,x_H2O_liq_old,p_in_1,rho_in_1,T_in_1,m_dot_air_in_1,x_H2O_gas_in_1,↙
x_CO2_in_1,x_H2O_liq_in_1,p_in_2,rho_in_2,T_in_2,m_dot_air_in_2,x_H2O_gas_in_2,↙
x_CO2_in_2,x_H2O_liq_in_2,p_in_3,rho_in_3,T_in_3,m_dot_air_in_3,x_H2O_gas_in_3,↙
x_CO2_in_3,x_H2O_liq_in_3,Delta_p_threshold)

% ************************************************************************
% * Definition of a node with 3 apertures
% *
% * Number of Inputs:        3
% *
% * Parameter:               Threshold Equality Input/Output Pressures
% *
% *
% * Relevant input variables of Node_3D
% *
% * Pressure:                p
% * Density:                 rho
% * Temperature:             T
% * Mass flow dry air:       m_dot_air
% * Content water vapor:     x_H2O_gas
% * Content CO2:             x_CO2
% * Content water:           x_H2O_liq
% *
% *
% * Relevant output variables of Node_3D
% *
% * Pressure:                p
% * Density:                 rho
% * Temperature:             T
% * Content water vapor:     x_H2O_gas
% * Content CO2:             x_CO2
% * Content water:           x_H2O_liq
% *
% ***********************************************************************
% * Embedded MATLAB Function Cal:
% *
% * Calculations:
% * 1. Definition specific gas constants.
% * 2. Definition state variables.
% * 3. Redefinition of the input variables.
% * 4. Consistency check.
% * 5. Operation mode: Determination of the pressure
% *                    5.1. Calculation pressure
% *                    5.2. Calculation temperature, water vapor content,
% *                         CO2-content, water content
% *
% *
% * Assumptions:
% * 1. The gas mixture inside the volume consists of water vapor (H2O_gas),
% *    CO2 and water (H2O_liq, state: fog).
% * 4. Consistency Check:
% *    check = 1: Operation mode
% *    check = 0: Standby mode
% *    Conditions for the standby mode:
% *    a) All mass flows are incoming mass flows (sign: plus)
```

```
% *    b) All mass flows are outgoing mass flows (sign: minus)
% *    c) All mass flows are equal zero
% * 5. Operation mode:
% *    5.1. Calculation pressure
% *
% *         Linearization: For each time step the following equations will
% *                        be resolved for the constants K_1, K_2 and K_3.
% *                        K_1, K_2 and K_3 are time dependant.
% *
% *                        m_dot_1 = K_1*(p_in_1-p)
% *                        m_dot_2 = K_2*(p_in_2-p)
% *                        m_dot_3 = K_3*(p_in_3-p)
% *
% *         Calculation pressure: Assuming that the constants are fixed within
% *                               one time step, a estimation for the pressure
% *                               can be made. the sum of the incoming and the
% *                               outgoing mass flows has to be zero.
% *                               (m_dot_1+m_dot_2+m_dot_3 = 0)
% *
% *                               m_dot_1+m_dot_2+m_dot_3 = 0
% *                               => K_1*(p_in_1-p)+K_2*(p_in_2-p)+K_3*(p_in_3-p) = 0
% *                               => p = (K_1*p_in_1+K_2*p_in_2+K_3*p_in_3)/↙
(K_1+K_2+K_3)
% *
% *                               In the case that one mass flow is constant.
% *                               e.g. m_dot_1 = const. The pressure has to be
% *                               calculated by the following equation.
% *
% *                               p = (m_dot_1+K_2*p_in_2+K_3*p_in_3)/(K_2+K_3)
% *
% *                               For stability reasons p_in_1, p_in_2 or p_in_3 and
% *                               p will be assumed as equal, then e.g.
% *                               (p_in_1-p) < Delta_p_threshold
% *
% *    5.2. Calculation temperature, water vapor content, CO2-content, water content
% *
% *         The state variables of incoming mass flows contibute to the
% *         calculation of the temperature, the water vapor content,
% *         the CO2-content and the water content of the node. The values
% *         will be calculated by a weighted average. The state variables
% *         of the outgoing mass flows will be determined by the node.
% *
% *
% * Last modification : 15.03.2008
% * Author : Christian Müller(HAW)
% *
% **********************************************************************

% * 1. Definition specific gas constants
R_air             = 287.058;
R_H2O_gas         = 461.523;
R_CO2             = 188.924;
% **********************************************************************

% * 2. Definition state variables
p                 = p_old;
```

```
rho               = rho_old;
T                 = T_old;
x_H2O_gas         = x_H2O_gas_old;
x_CO2             = x_CO2_old;
x_H2O_liq         = x_H2O_liq_old;
% ************************************************************************

% * 3. Calculation incoming and outgoing mass flows
m_dot_1           =↙
m_dot_air_in_1+m_dot_air_in_1*x_H2O_gas_in_1+m_dot_air_in_1*x_CO2_in_1;
m_dot_2           =↙
m_dot_air_in_2+m_dot_air_in_2*x_H2O_gas_in_2+m_dot_air_in_2*x_CO2_in_2;
m_dot_3           =↙
m_dot_air_in_3+m_dot_air_in_3*x_H2O_gas_in_3+m_dot_air_in_3*x_CO2_in_3;
% ************************************************************************

% * 4. Consistency check
check             = 1;

if m_dot_1 > 0
   if m_dot_2 > 0
      if m_dot_3 > 0
         check    = 0;
      end
   end
end

if m_dot_1 < 0
   if m_dot_2 < 0
      if m_dot_3 < 0
         check    = 0;
      end
   end
end

if abs(m_dot_1)+abs(m_dot_2)+abs(m_dot_3) == 0
   check          = 0;
end
% ************************************************************************

% * 5. Operation mode:
% * 5.1. Calculation pressure
if check == 1
   Numerator      = 0;
   Denominator    = 0;

   if p_in_1 == 0
      Numerator   = Numerator+m_dot_1;
   else
      if abs(p_in_1-p) < Delta_p_threshold
         K_1      = 0;
      else
         K_1      = abs(m_dot_1)/abs(p_in_1-p);
      end

      Numerator   = Numerator+K_1*p_in_1;
```

```
      Denominator = Denominator+K_1;
   end

   if p_in_2 == 0
      Numerator   = Numerator+m_dot_2;
   else
      if abs(p_in_2-p) < Delta_p_threshold
         K_2      = 0;
      else
         K_2      = abs(m_dot_2)/abs(p_in_2-p);
      end

      Numerator   = Numerator+K_2*p_in_2;
      Denominator = Denominator+K_2;
   end

   if p_in_3 == 0
      Numerator   = Numerator+m_dot_3;
   else
      if abs(p_in_3-p) < Delta_p_threshold
         K_3      = 0;
      else
         K_3      = abs(m_dot_3)/abs(p_in_3-p);
      end

      Numerator   = Numerator+K_3*p_in_3;
      Denominator = Denominator+K_3;
   end

   if Denominator > 0
      p           = Numerator/Denominator;
   end
end
% ************************************************************************

% * 5.2. Calculation temperature, water vapor content, CO2-content,
% *      water content
if check == 1
   Denominator    = 0;
   T              = 0;
   x_H2O_gas      = 0;
   x_CO2          = 0;
   x_H2O_liq      = 0;

   if m_dot_1 > 0
      T           = T+m_dot_1*T_in_1;
      x_H2O_gas   = x_H2O_gas+m_dot_1*x_H2O_gas_in_1;
      x_CO2       = x_CO2+m_dot_1*x_CO2_in_1;
      x_H2O_liq   = x_H2O_liq+m_dot_1*x_H2O_liq_in_1;
      Denominator = Denominator+m_dot_1;
   end

   if m_dot_2 > 0
      T           = T+m_dot_2*T_in_2;
      x_H2O_gas   = x_H2O_gas+m_dot_2*x_H2O_gas_in_2;
      x_CO2       = x_CO2+m_dot_2*x_CO2_in_2;
```

```
      x_H2O_liq   = x_H2O_liq+m_dot_2*x_H2O_liq_in_2;
      Denominator = Denominator+m_dot_2;
   end

   if m_dot_3 > 0
      T           = T+m_dot_3*T_in_3;
      x_H2O_gas   = x_H2O_gas+m_dot_3*x_H2O_gas_in_3;
      x_CO2       = x_CO2+m_dot_3*x_CO2_in_3;
      x_H2O_liq   = x_H2O_liq+m_dot_3*x_H2O_liq_in_3;
      Denominator = Denominator+m_dot_3;
   end

   if abs(Denominator) > 0
      T           = T/Denominator;
      x_H2O_gas   = x_H2O_gas/Denominator;
      x_CO2       = x_CO2/Denominator;
      x_H2O_liq   = x_H2O_liq/Denominator;
      R_avg       = (R_air+x_H2O_gas*R_H2O_gas+x_CO2*R_CO2)/(1+x_H2O_gas+x_CO2);
      rho         = p/(R_avg*T);
   else
      T           = T_old;
      rho         = rho_old;
      x_H2O_gas   = x_H2O_gas_old;
      x_CO2       = x_CO2_old;
      x_H2O_liq   = x_H2O_liq_old;
   end
end
% **********************************************************************
% **********************************************************************
```