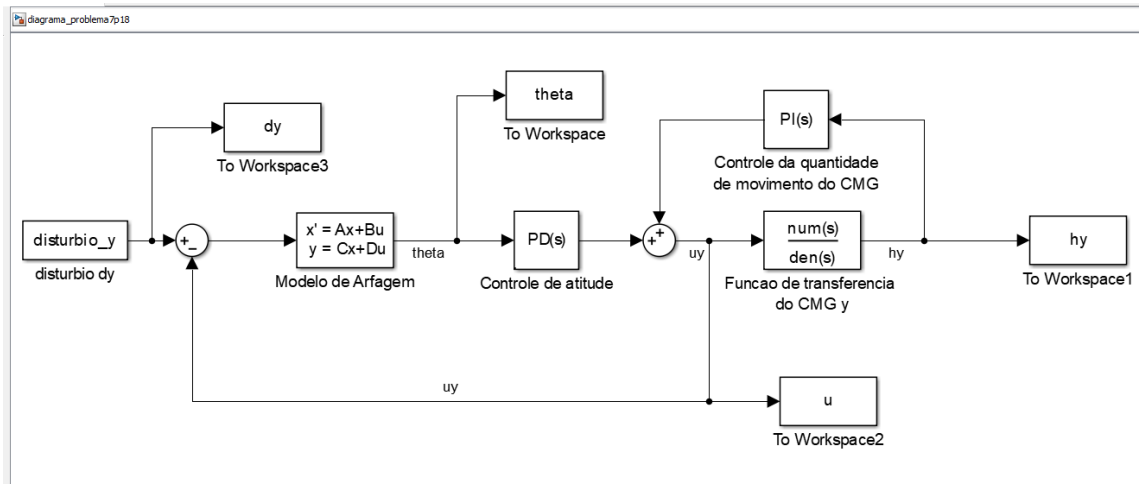
modelo_iss_cmg.m | problema7p18.m

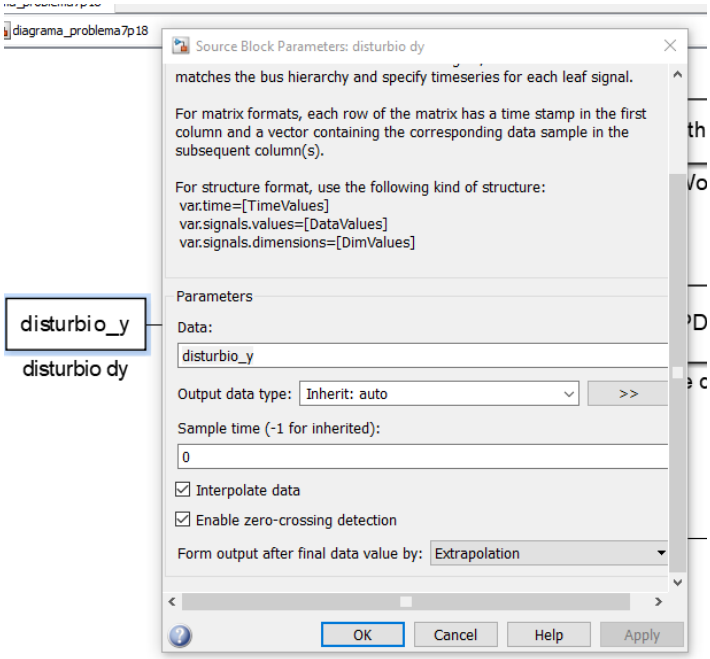
```
% IMPORTANTE: para passar parametros ao Simulink, o programa nao pode ser
% uma funcao, mas um script
%% Problema 7.18 - projeto do controle de arfagem por alocacao de polos
% e sem filtro
%%
clc;clear all;close all;
% Dados
hmax=14e3; % lb.ft.s
hmax=hmax*0.3048*4.4482216; % N.m
n=0.0011;   % rad/s
% Requisito - polos de malha fechada desejados
pr(1)=-1.5*n;pr(2)=-1*n;pr(3)=(-1.5+1i*1.5)*n;pr(4)=(-1.5-1i*1.5)*n;
% Chama a funcao da dinamica
[A,B,B2,ftarf,ftrg]=modelo_iss_cmg;
% Matrizes do modelo de espaco de estados de ordem reduzida de arfagem
%  1  2     3   4   5     6   7  8 9
% [wx Dwy wz phi theta psi hx hy hz] -> [thetap theta hy]  (Dwy=thetap)
%  1   2   3
% [ux uy uz] -> [uy].
Aa=[A(2,2) A(2,5) A(2,8)
      A(5,2) A(5,5) A(5,8)
      A(8,2) A(8,5) A(8,8)];
Ba=[B(2,2)
       B(5,2)
       B(8,2)];
B2a=[B2(2,2)
       B2(5,2)
       B2(8,2)];
% Insere uma variavel de estado adicional referente a integral do momento
% angular hy
Aa=[Aa zeros(3,1)
      0 0 1 0];
Ba=[Ba;0];
B2a=[B2a;0];
% Matriz de ganhos de realimentacao de estado determinada por alocacao de
% polos
K=place(Aa,Ba,pr);
% Desmembra os ganhos do controlador - o diagrama usa o controle com sinal
% positivo ao inves de negativo, necessario trocar nos ganhos.
kyp=-K(2)   % Realimentacao de theta
kyd=-K(1)   % Realimentacao de thetap
kyh=-K(3)   % Realimentacao de hy
```

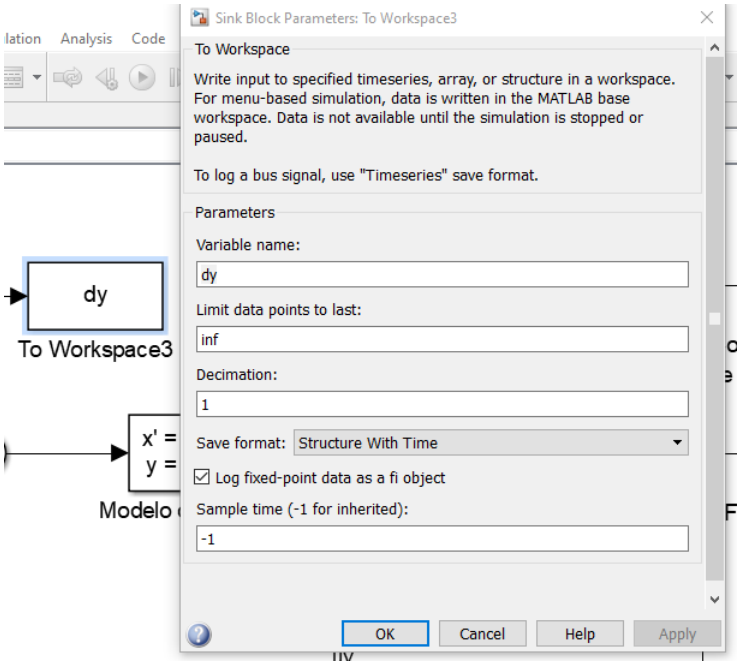
```
kyi=-K(4)   % Realimentacao da int(hy)
% Matriz A de malha fechada
Ac=Aa-Ba*K;
% Polos de malha fechada
damp(Ac)
% Modelo de espaco de estados de malha fechada - saidas theta e hy, entrada
% dy
C=[0 1 0 0;0 0 1 0];D=[0;0];
mfarf=ss(Ac,B2a,C,D);
% Funcoes de transferencia de malha fechada
mfftarf=zpk(mfarf)
% Diagrama de bode da saida theta com respeito a entrada dy em malha
% fechada
figure();bode(mfftarf(1,1));grid;
% Diagrama de bode da saida hy com respeito a entrada dy em malha
% fechada
figure();bode(mfftarf(2,1));grid;
% Entradas do simulink
global T disturbio_y
T=5*2*pi/n; % 4 orbitas - intervalo da simulacao
t=0:30:T;   % Vetor de tempos
```

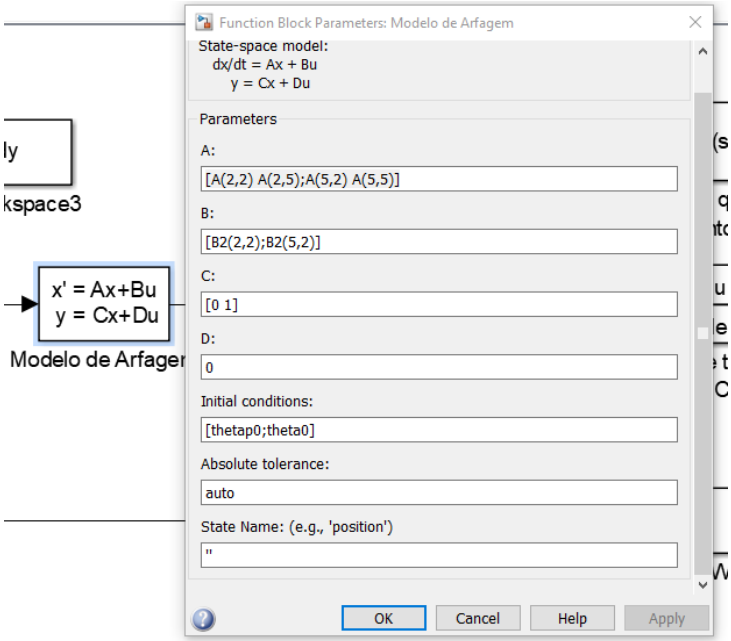
```
t=t';   % Vetor coluna
N=length(t);
d=zeros(N,1);   % Vetor de perturbacao dy em funcao do tempo
for j=1:N
   d(j)=4+2*sin(n*t(j))+0.5*sin(2*n*t(j)); % foot.pound
   d(j)=d(j)*0.3048*4.4482216; % N.m
end
% Estrutura enviada ao Simulink
disturbio_y.time=t;
disturbio_y.signals.values=d;
% Condicoes iniciais
theta0=1*pi/180;thetap0=0.001*pi/180;
% Simula
sim('diagrama_problema7p18');
% Resultados
t=theta.time;
N=length(t);
theta=theta.signals.values;
hy=hy.signals.values;
u=u.signals.values;
dy=dy.signals.values;
```

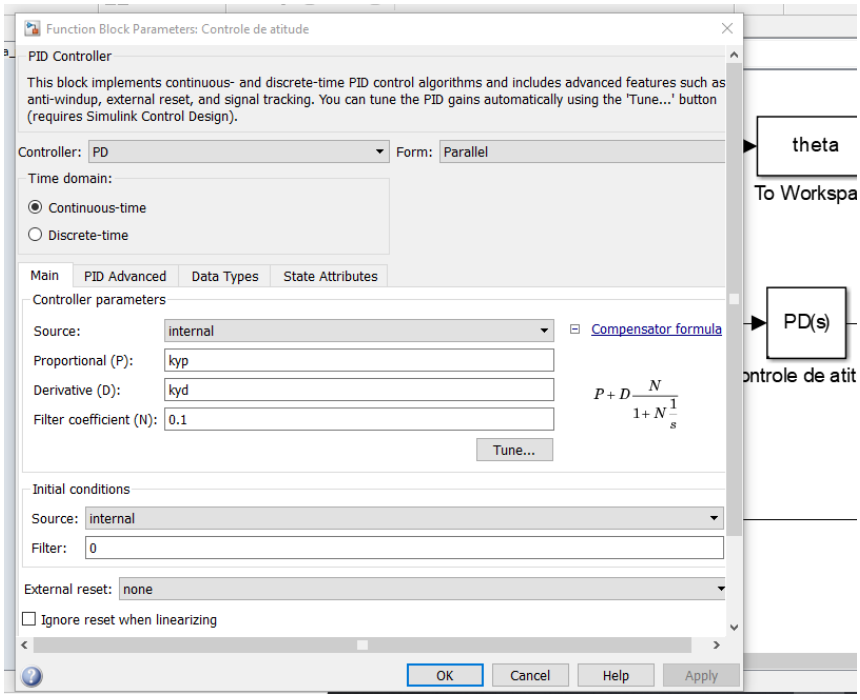
```
% Graficos
figure()
subplot(221);plot(t,theta*180/pi);grid;xlabel('t (s)');ylabel('\theta (°)')
subplot(222);plot(t,hy,t,hmax*ones(1,N),t,-hmax*ones(1,N));grid;xlabel('t (s)');ylabel('h_y (N.m.s)');
subplot(223);plot(t,dy);grid;xlabel('t (s)');ylabel('d_y (N.m)');
subplot(224);plot(t,u);grid;xlabel('t (s)');ylabel('u_y (N.m)');
```

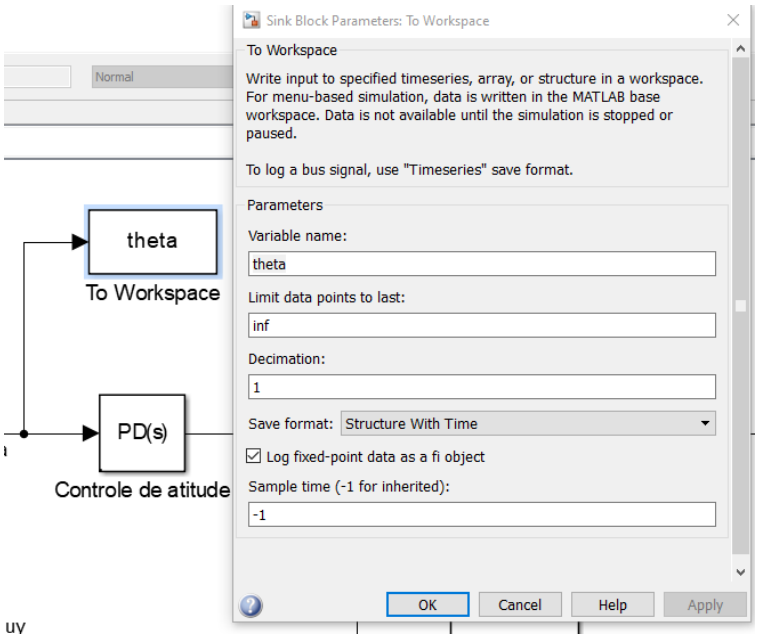

diagrama_problema7p18
dy
To Workspace3
theta
To Workspace
PI(s)
Controle da quantidade
de movimento do CMG
disturbio_y
disturbio dy
x' = Ax+Bu
y = Cx+Du
Modelo de Arfagem
theta
PD(s)
Controle de atitude
uy
num(s)
den(s)
Funcao de transferencia
do CMG y
hy
hy
To Workspace1
uy
u
To Workspace2

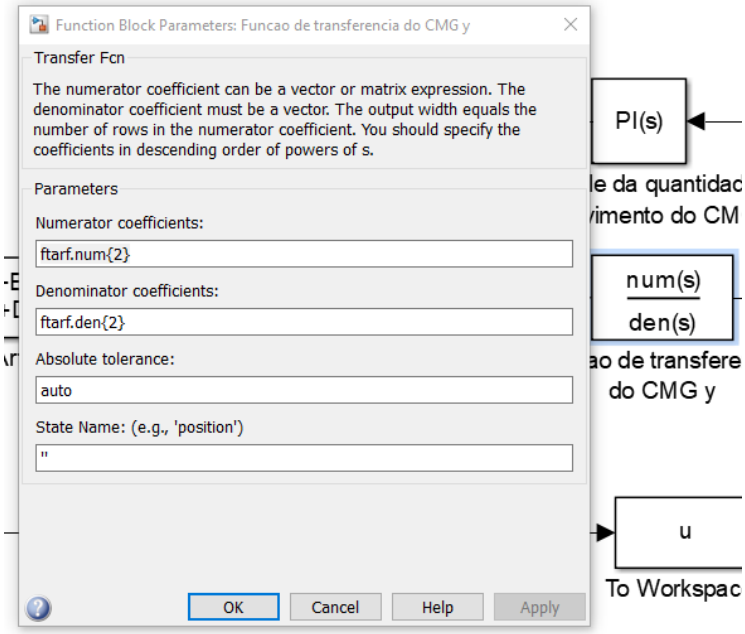

diagrama_problema7p18
Source Block Parameters: disturbio dy
matches the bus hierarchy and specify timeseries for each leaf signal.
For matrix formats, each row of the matrix has a time stamp in the first column and a vector containing the corresponding data sample in the subsequent column(s).
For structure format, use the following kind of structure:
var.time=[TimeValues]
var.signals.values=[DataValues]
var.signals.dimensions=[DimValues]
Parameters
Data:
disturbio_y
Output data type: Inherit: auto
>>
Sample time (-1 for inherited):
0
Interpolate data
Enable zero-crossing detection
Form output after final data value by: Extrapolation
OK
Cancel
Help
Apply
disturbio_y
disturbio dy

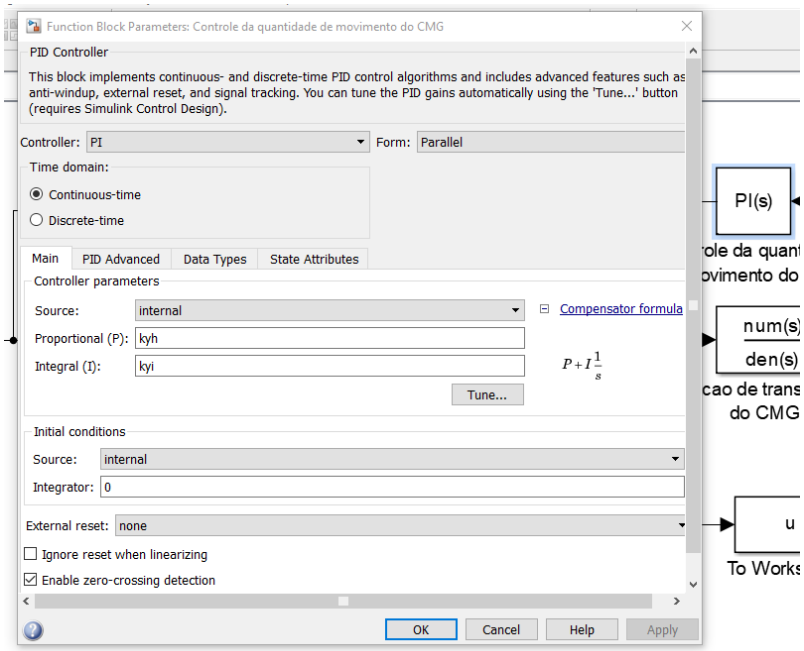

Sink Block Parameters: To Workspace3
To Workspace
Write input to specified timeseries, array, or structure in a workspace. For menu-based simulation, data is written in the MATLAB base workspace. Data is not available until the simulation is stopped or paused.
To log a bus signal, use "Timeseries" save format.
Parameters
Variable name:
dy
Limit data points to last:
inf
Decimation:
1
Save format: Structure With Time
Log fixed-point data as a fi object
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply
dy
To Workspace3

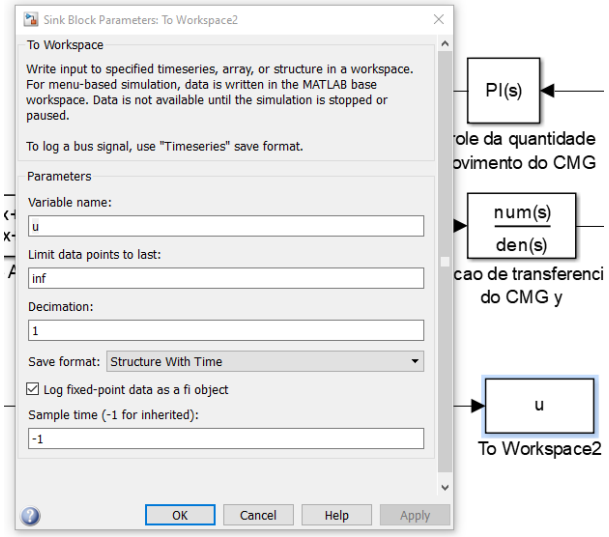

Function Block Parameters: Modelo de Arfagem
State-space model:
dx/dt = Ax + Bu
y = Cx + Du
Parameters
A:
[A(2,2) A(2,5);A(5,2) A(5,5)]
B:
[B2(2,2);B2(5,2)]
C:
[0 1]
D:
0
Initial conditions:
[thetap0;theta0]
Absolute tolerance:
auto
State Name: (e.g., 'position')
''
OK
Cancel
Help
Apply
x' = Ax+Bu
y = Cx+Du
Modelo de Arfager
kspace3

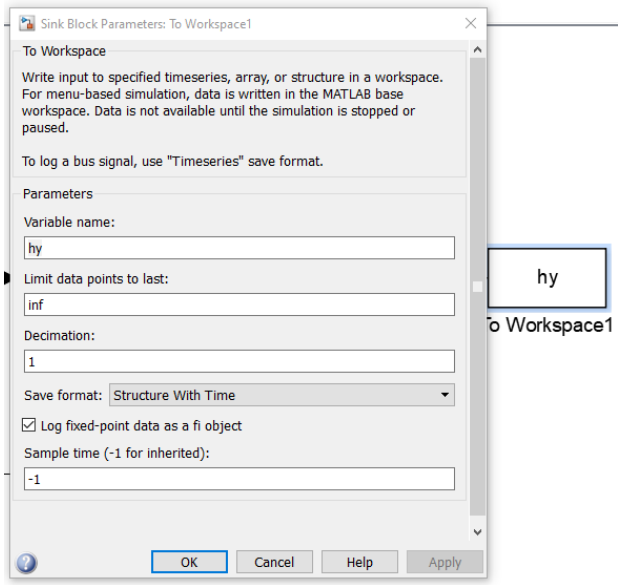

Function Block Parameters: Controle de atitude
PID Controller
This block implements continuous- and discrete-time PID control algorithms and includes advanced features such as anti-windup, external reset, and signal tracking. You can tune the PID gains automatically using the 'Tune...' button (requires Simulink Control Design).
Controller: PD
Form: Parallel
Time domain:
Continuous-time
Discrete-time
Main
PID Advanced
Data Types
State Attributes
Controller parameters
Source: internal
Compensator formula
Proportional (P): kyp
Derivative (D): kyd
Filter coefficient (N): 0.1
Tune...
Initial conditions
Source: internal
Filter: 0
External reset: none
Ignore reset when linearizing
OK
Cancel
Help
Apply
theta
To Workspa
PD(s)
ntrole de atit


Normal
theta
To Workspace
PD(s)
Controle de atitude
uv
Sink Block Parameters: To Workspace
To Workspace
Write input to specified timeseries, array, or structure in a workspace. For menu-based simulation, data is written in the MATLAB base workspace. Data is not available until the simulation is stopped or paused.
To log a bus signal, use "Timeseries" save format.
Parameters
Variable name:
theta
Limit data points to last:
inf
Decimation:
1
Save format: Structure With Time
Log fixed-point data as a fi object
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply


Function Block Parameters: Funcao de transferencia do CMG y
Transfer Fcn
The numerator coefficient can be a vector or matrix expression. The denominator coefficient must be a vector. The output width equals the number of rows in the numerator coefficient. You should specify the coefficients in descending order of powers of s.
Parameters
Numerator coefficients:
ftarf.num{2}
Denominator coefficients:
ftarf.den{2}
Absolute tolerance:
auto
State Name: (e.g., 'position')
''
OK
Cancel
Help
Apply
PI(s)
num(s)
den(s)
u
To Workspac


Function Block Parameters: Controle da quantidade de movimento do CMG
PID Controller
This block implements continuous- and discrete-time PID control algorithms and includes advanced features such as anti-windup, external reset, and signal tracking. You can tune the PID gains automatically using the 'Tune...' button (requires Simulink Control Design).
Controller: PI
Form: Parallel
Time domain:
Continuous-time
Discrete-time
Main
PID Advanced
Data Types
State Attributes
Controller parameters
Source: internal
Compensator formula
Proportional (P): kyh
Integral (I): kyi
$P+I\frac{1}{s}$
Tune...
Initial conditions
Source: internal
Integrator: 0
External reset: none
Ignore reset when linearizing
Enable zero-crossing detection
OK
Cancel
Help
Apply
PI(s)
num(s)
den(s)
u
To Works


Sink Block Parameters: To Workspace2
To Workspace
Write input to specified timeseries, array, or structure in a workspace. For menu-based simulation, data is written in the MATLAB base workspace. Data is not available until the simulation is stopped or paused.
To log a bus signal, use "Timeseries" save format.
Parameters
Variable name: u
Limit data points to last: inf
Decimation: 1
Save format: Structure With Time
Log fixed-point data as a fi object
Sample time (-1 for inherited): -1
OK
Cancel
Help
Apply
PI(s)
num(s)
den(s)
u
To Workspace2


Sink Block Parameters: To Workspace1
To Workspace
Write input to specified timeseries, array, or structure in a workspace. For menu-based simulation, data is written in the MATLAB base workspace. Data is not available until the simulation is stopped or paused.
To log a bus signal, use "Timeseries" save format.
Parameters
Variable name: hy
Limit data points to last: inf
Decimation: 1
Save format: Structure With Time
Log fixed-point data as a fi object
Sample time (-1 for inherited): -1
OK
Cancel
Help
Apply
hy