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Important Note! LabVIEW no longer supports the LabVIEW Control Design and Simulation Module. Beginning with LabVIEW 2023 Q1, LabVIEW no longer supports the LabVIEW Control Design and Simulation Module.

Simulation and Control in LabVIEW

Hans-Petter Halvorsen

Contents

- Control System
- PID Controller
- LabVIEW Control Design and Simulation Module
- Practical Examples
  - 1. Order Process Simulation
  - Control System using built-in PID Controller

Introduction

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Introduction

- We will use LabVIEW and the LabVIEW Control Design and Simulation Module
- We will simulate a 1. Order Process/Differential Equation
- We will create a basic Control System using the built-in PID Controller

Control System

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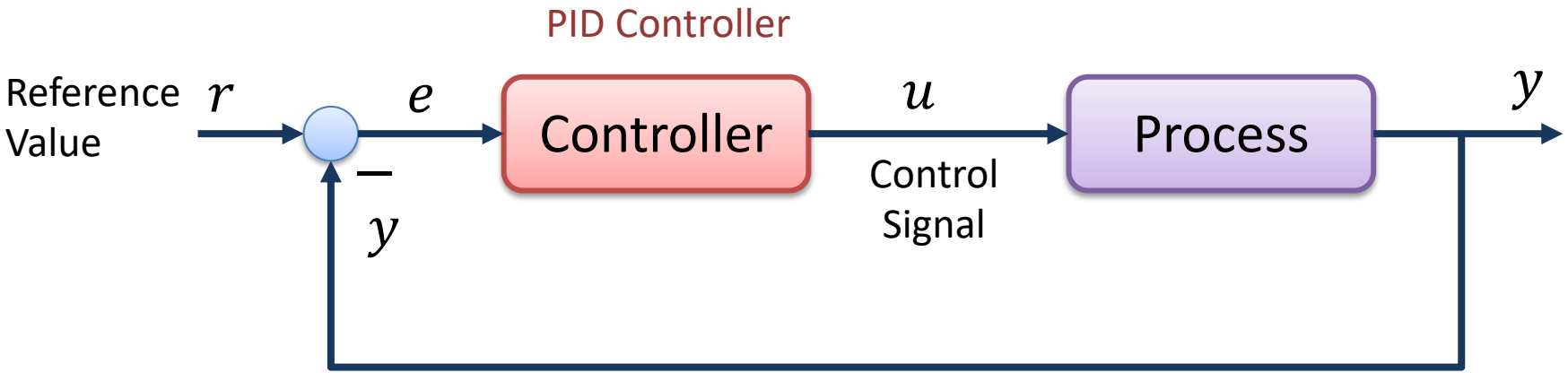
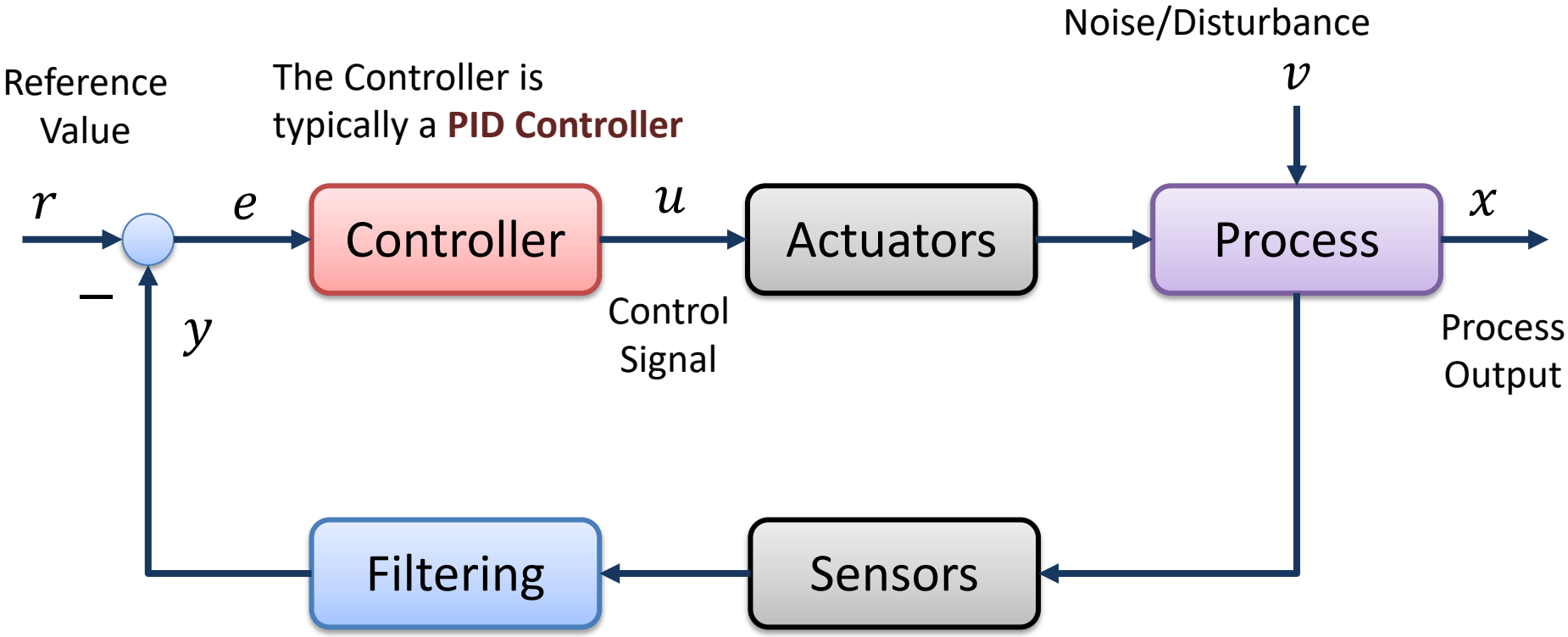
Control System

The purpose with a Control System is to Control a Dynamic System, e.g., an industrial process, an airplane, a self-driven car, etc. (a Control System is “everywhere“).



Control System



Control System

- r – Reference Value, SP (Set-point), SV (Set Value)
- y – Measurement Value (MV), Process Value (PV)
- e – Error between the reference value and the measurement value ($e = r - y$)
- v – Disturbance, makes it more complicated to control the process
- u - Control Signal from the Controller

PID Controller

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PID Control

- The PID Controller is the most used controller today
- It is easy to understand and implement
- There are few Tuning Parameters

PID Controller

$$u(t) = K_p e + \frac{K_p}{T_i}\int_0^t e d\tau + K_p T_d \dot{e}$$

Where u is the controller output and e is the control error:

$$e(t) = r(t) - y(t)$$

r is the Reference Signal or Set-point

y is the Process value, i.e., the Measured value

Tuning Parameters:

K_p Proportional Gain

T_i Integral Time [sec.]

T_d Derivative Time [sec.]

PID Controller

$$u(t) = \underbrace{K_p e}_{\text{P}} + \underbrace{\frac{K_p}{T_i}\int_0^t e d\tau}_{\text{I}} + \underbrace{K_p T_d \dot{e}}_{\text{D}}$$

	P	I	D
	Proportional Gain	Integral Time	Derivative Time
Tuning Parameters:	K_p	T_i	T_d

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LabVIEW Control Design and Simulation Module

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LabVIEW Control Design and Simulation Module

A separate LabVIEW Module

- Design Control Systems
- Simulation of Mathematical Models
- Implementation of Control Systems
- MPC (Model Predictive Control)
- System Identification and Kalman Filter
- etc.

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LabVIEW Control Design and Simulation Module

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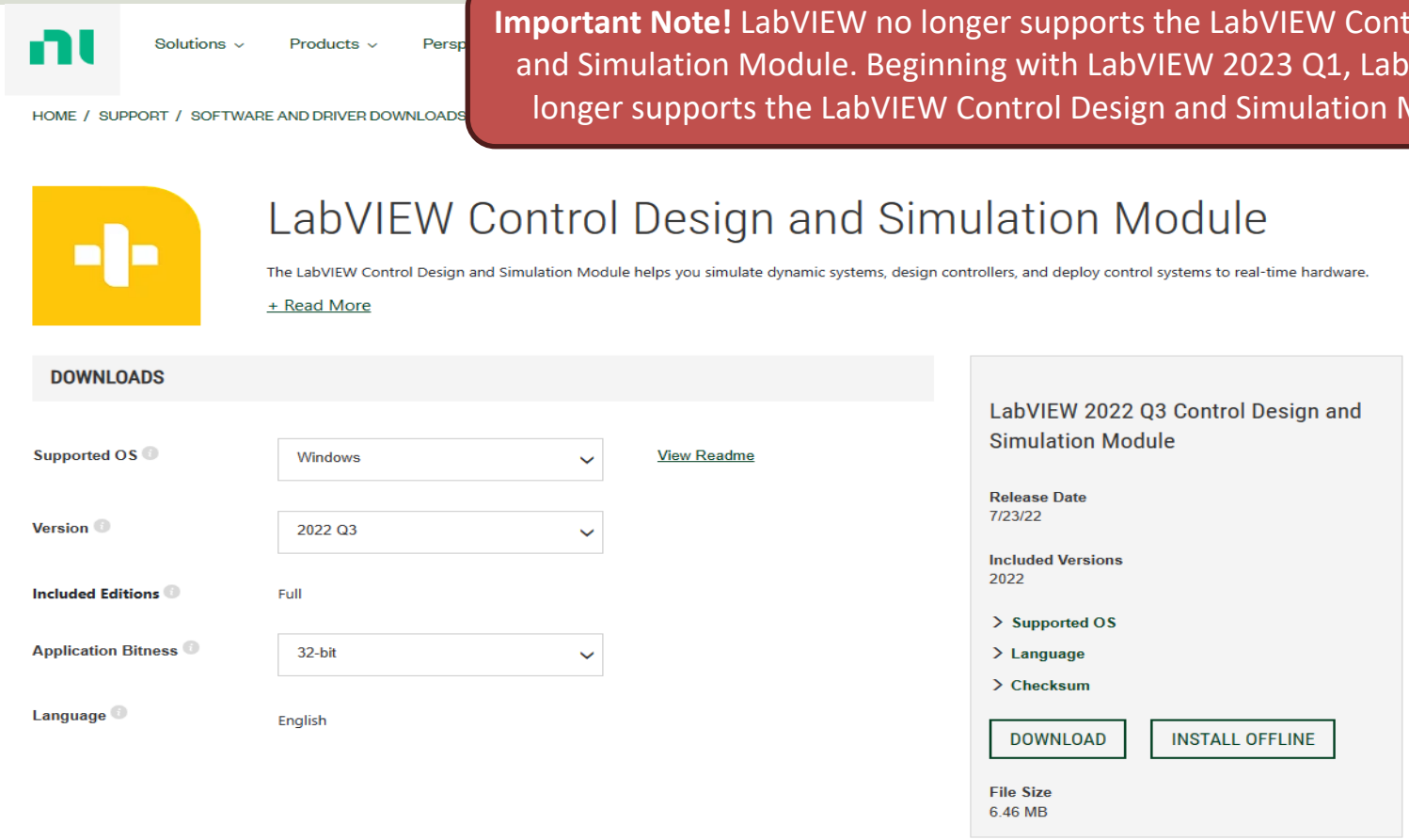
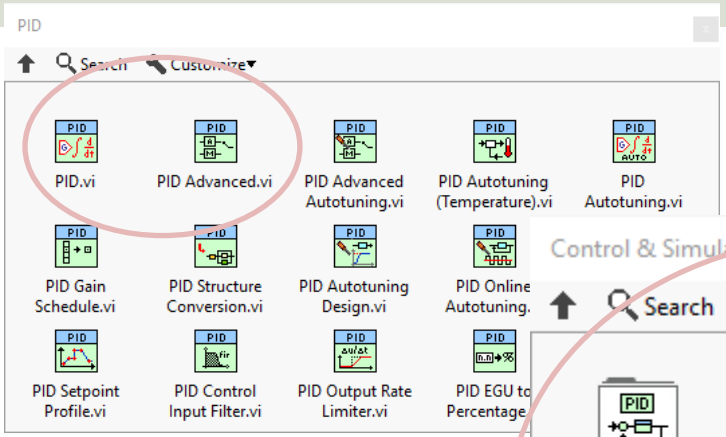
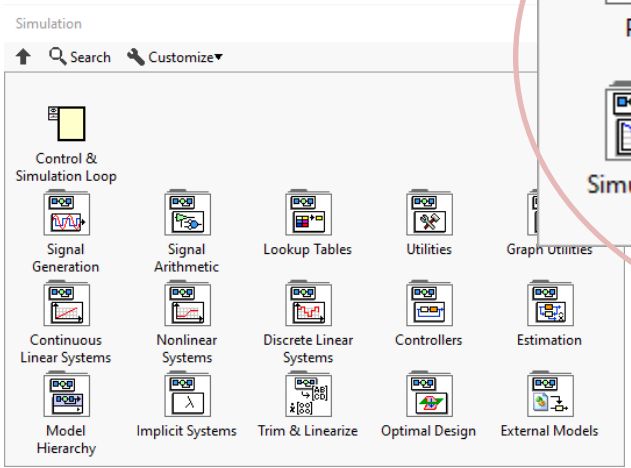
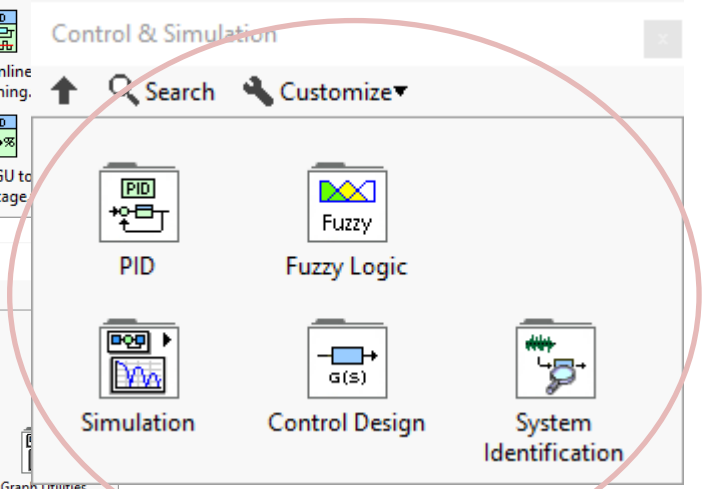
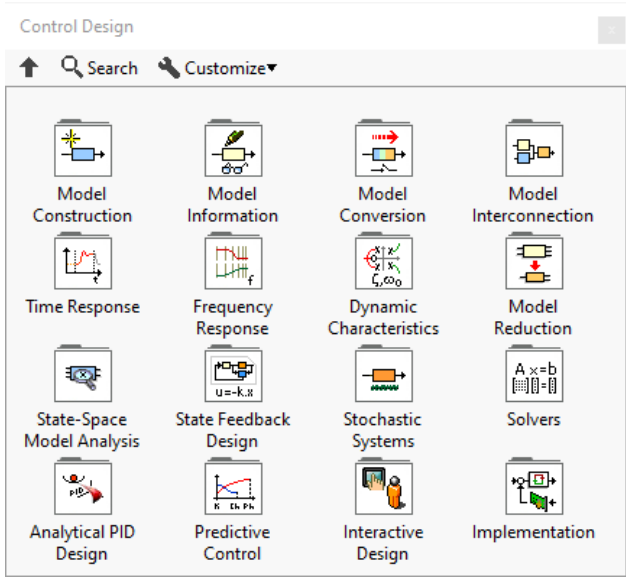


LabVIEW Control Design and Simulation Module









1. Order Process

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1. Order System

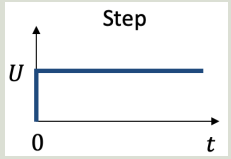
Differential Equation of a 1. order System:

$$\dot{x} = -ax + bu$$

$$y = x$$

In order to simulate this model in LabVIEW you can make a discrete version of the model, or you can implement it as a “Block Diagram” using the features in LabVIEW Control Design and Simulation Module

1. order Step Response



$y(t)$

100%

63%

KU

$$y(t) = KU(1 - e^{-\frac{t}{T}})$$

$$H(s) = \frac{y(s)}{u(s)} = \frac{K}{Ts + 1}$$

t

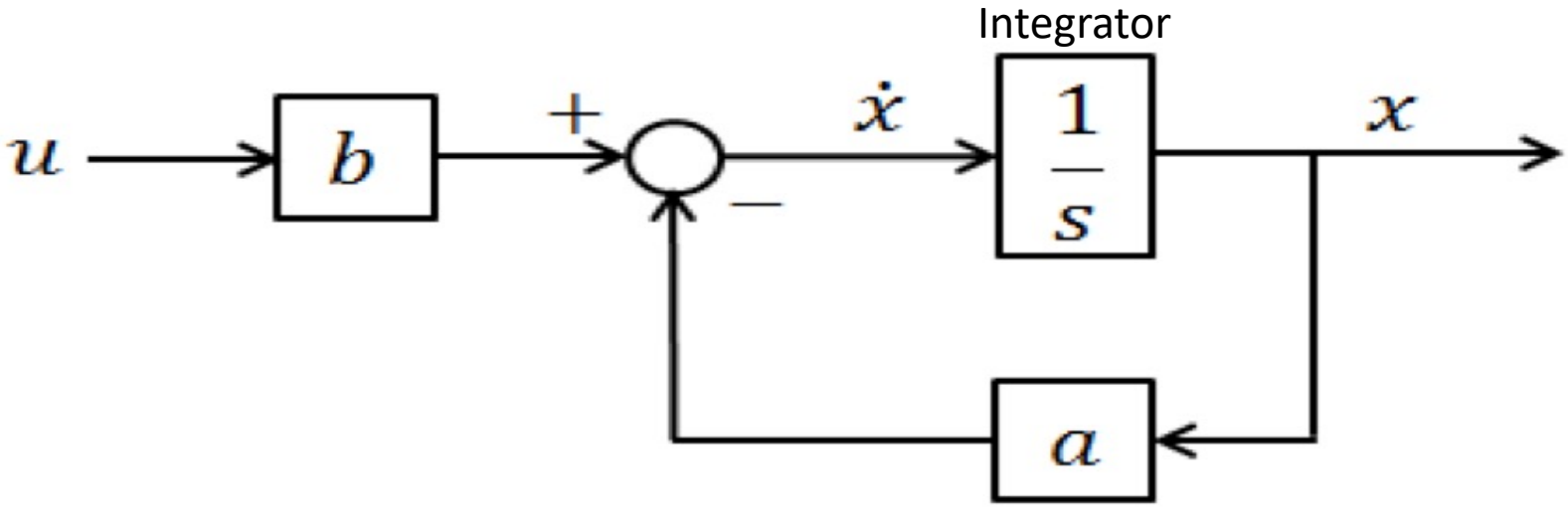
T

Model – Block Diagram

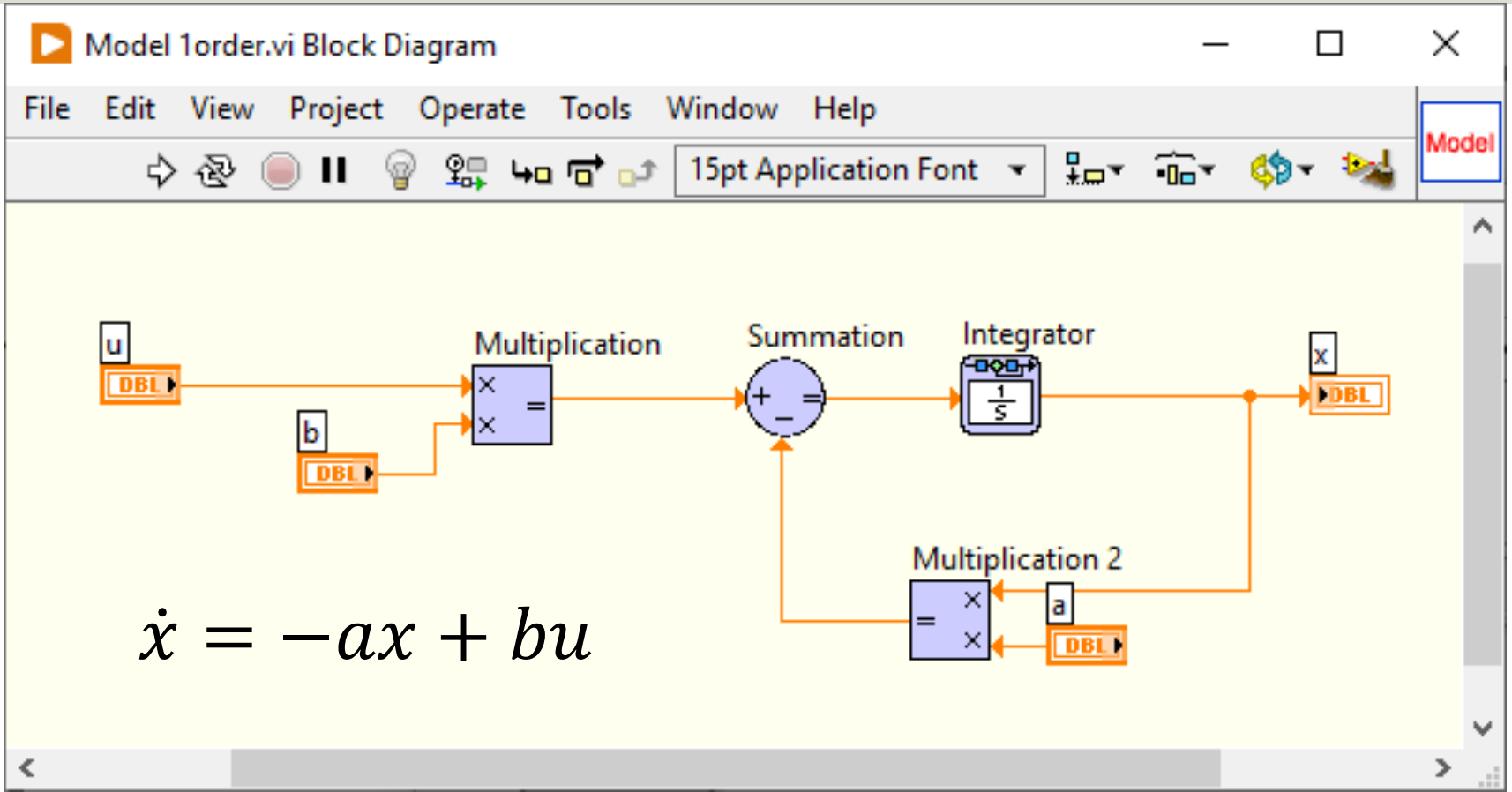
The first order differential equation:

$$\dot{x} = -ax + bu$$

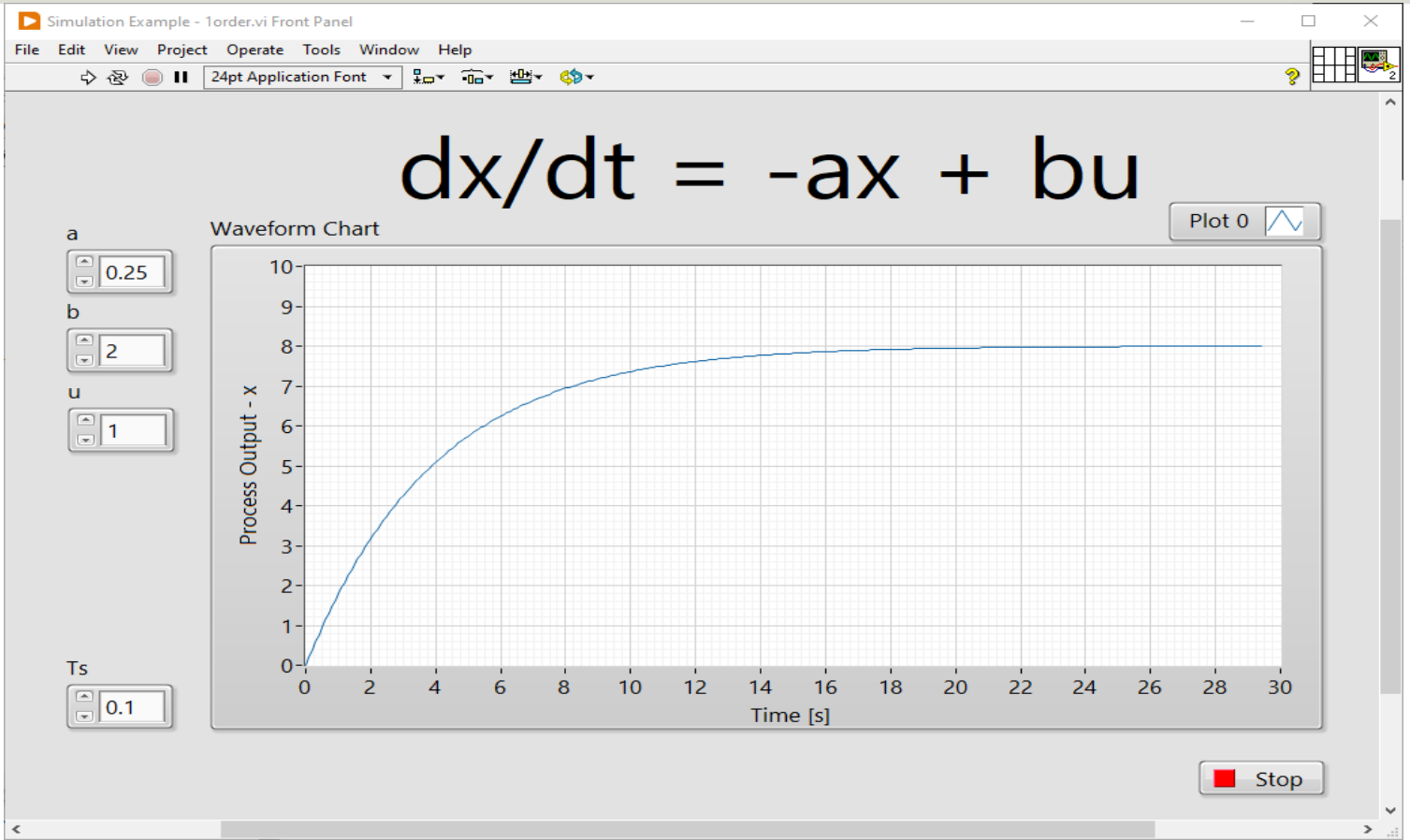
Can be described with the following block diagram model:



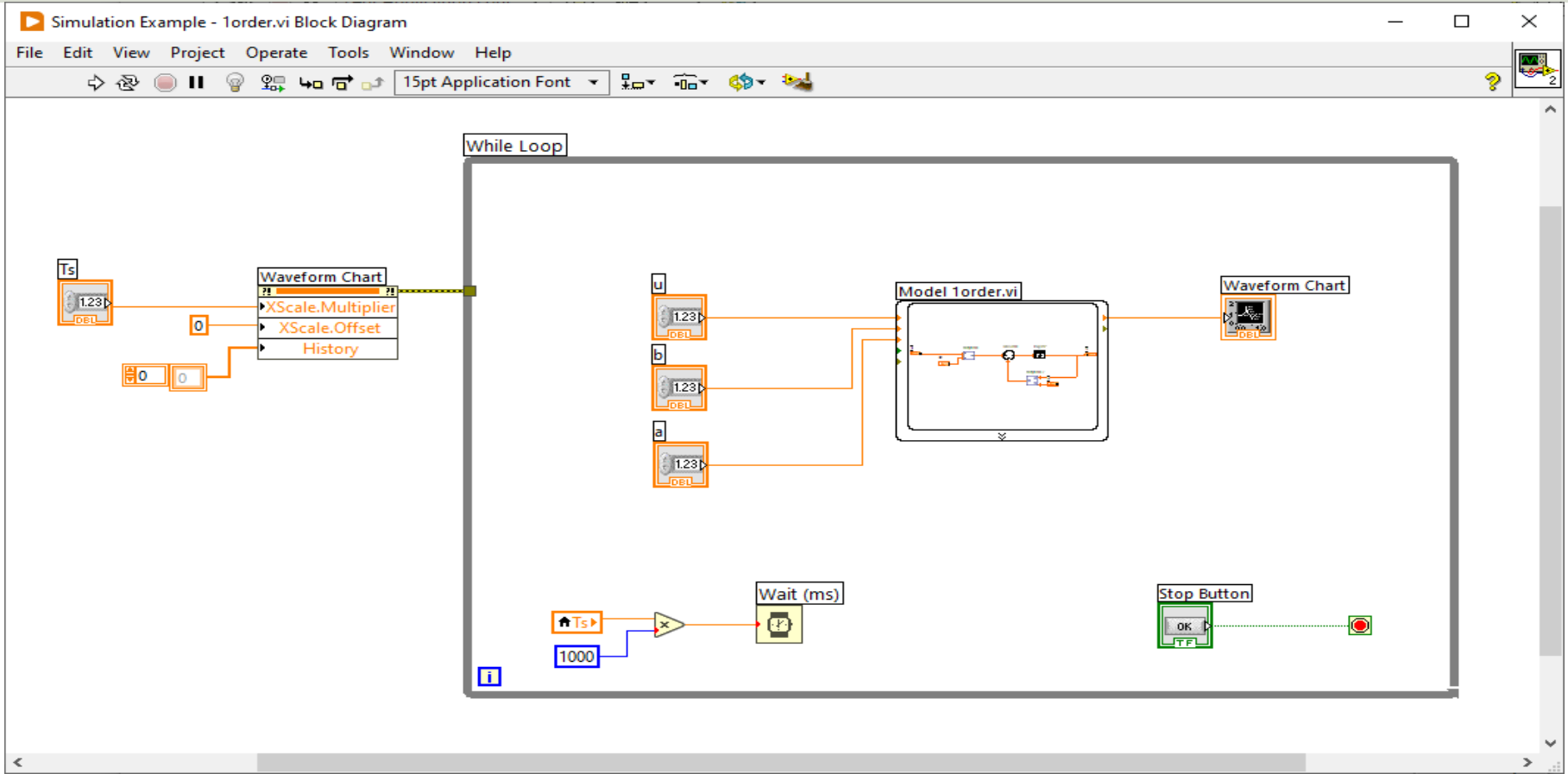
Model in LabVIEW



Simulation in LabVIEW



Code


Simulation Example - 1order.vi Block Diagram
File Edit View Project Operate Tools Window Help
15pt Application Font
While Loop
Ts
Waveform Chart
XScale.Multiplier
XScale.Offset
History
0
0
u
b
a
Model 1order.vi
Waveform Chart
Wait (ms)
Ts
1000
Stop Button
OK
TF
i

Control System

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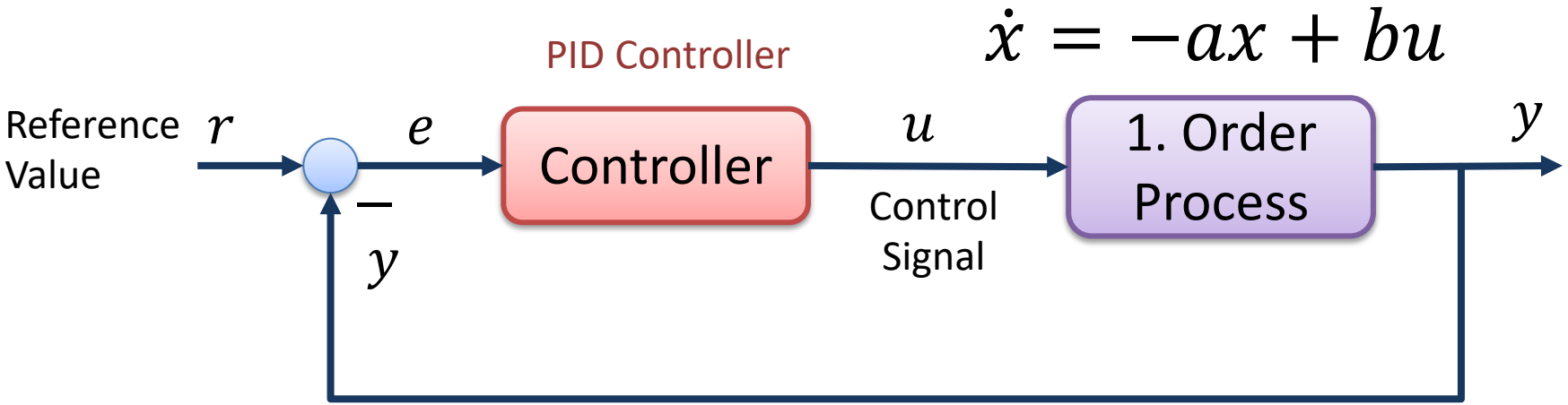
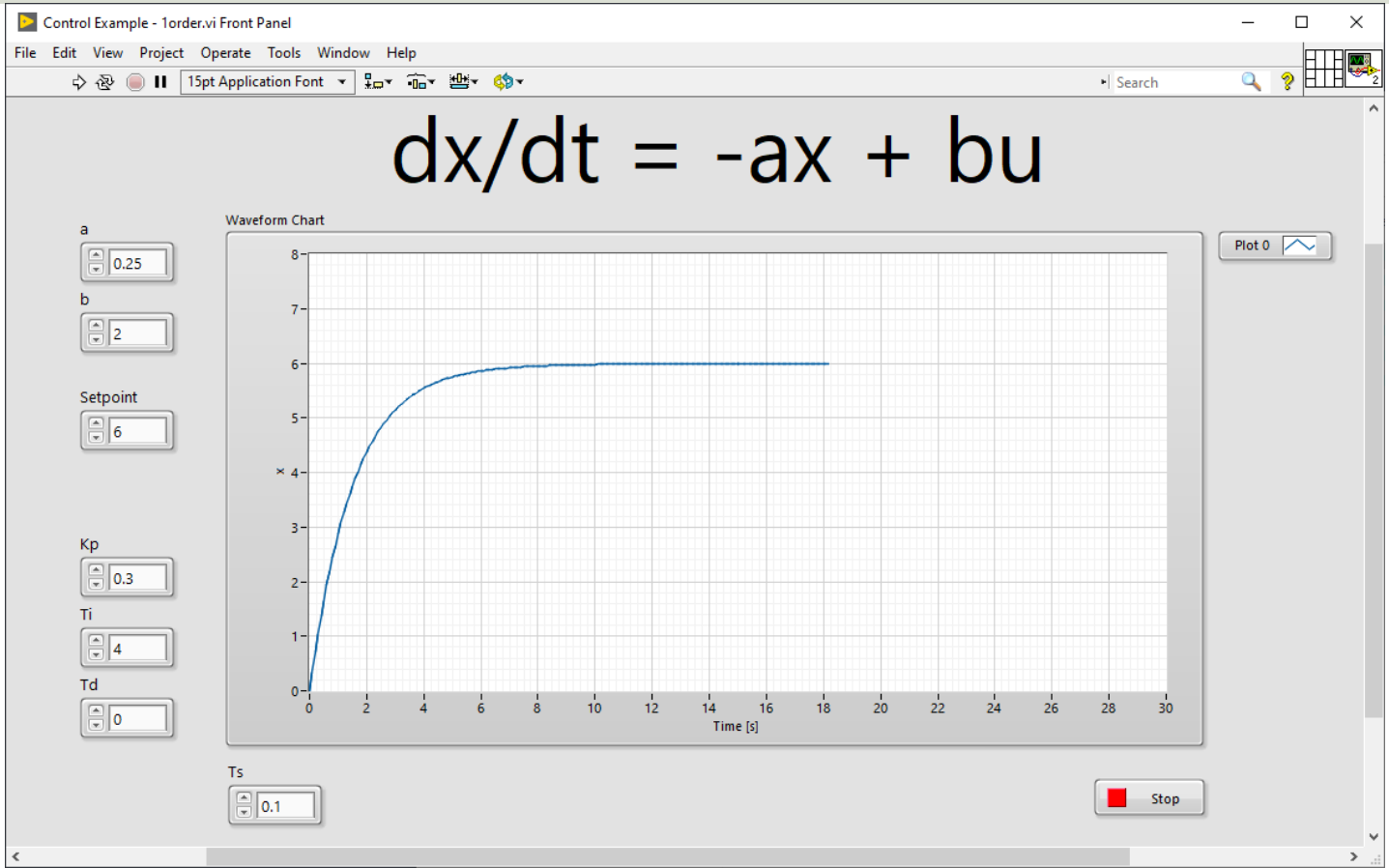
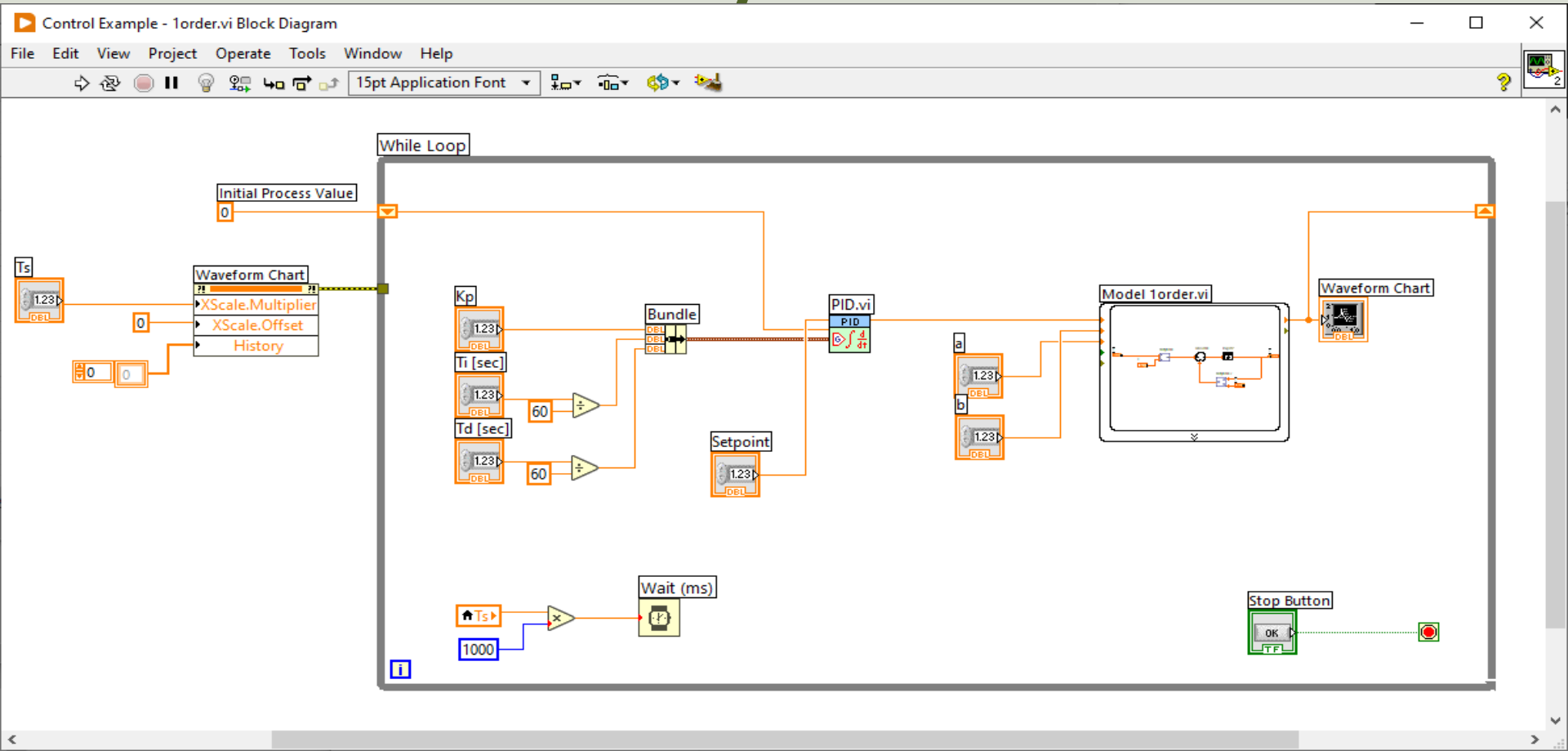
Control System



Control System in LabVIEW



Control System Code



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