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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

Introduction

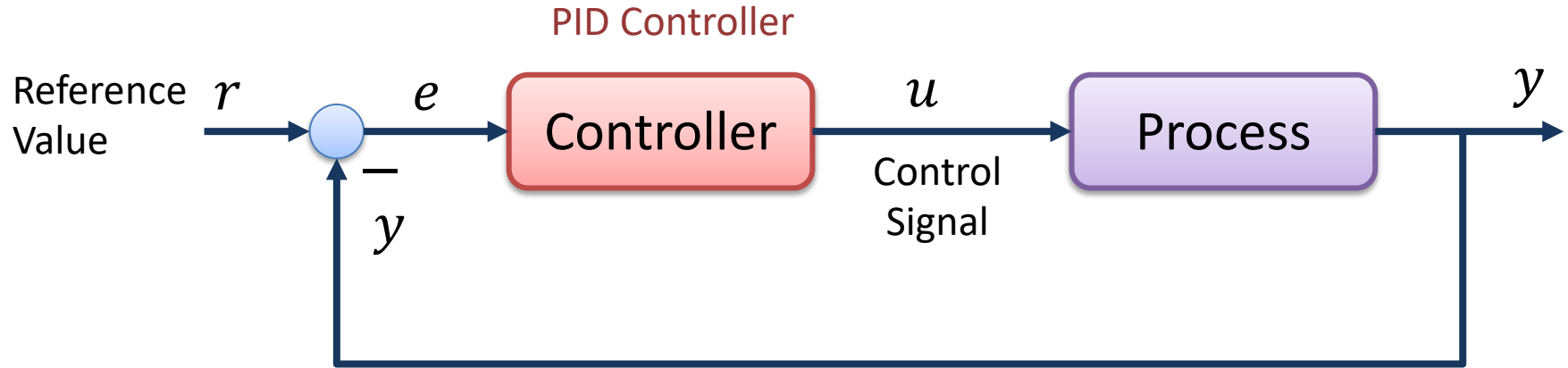
- We will use LabVIEW and the LabVIEW Control Design and Simulation Module
- We will simulate a 1. Order Process/Differential Equation
- We will create a basic Control System using the built-in PID Controller



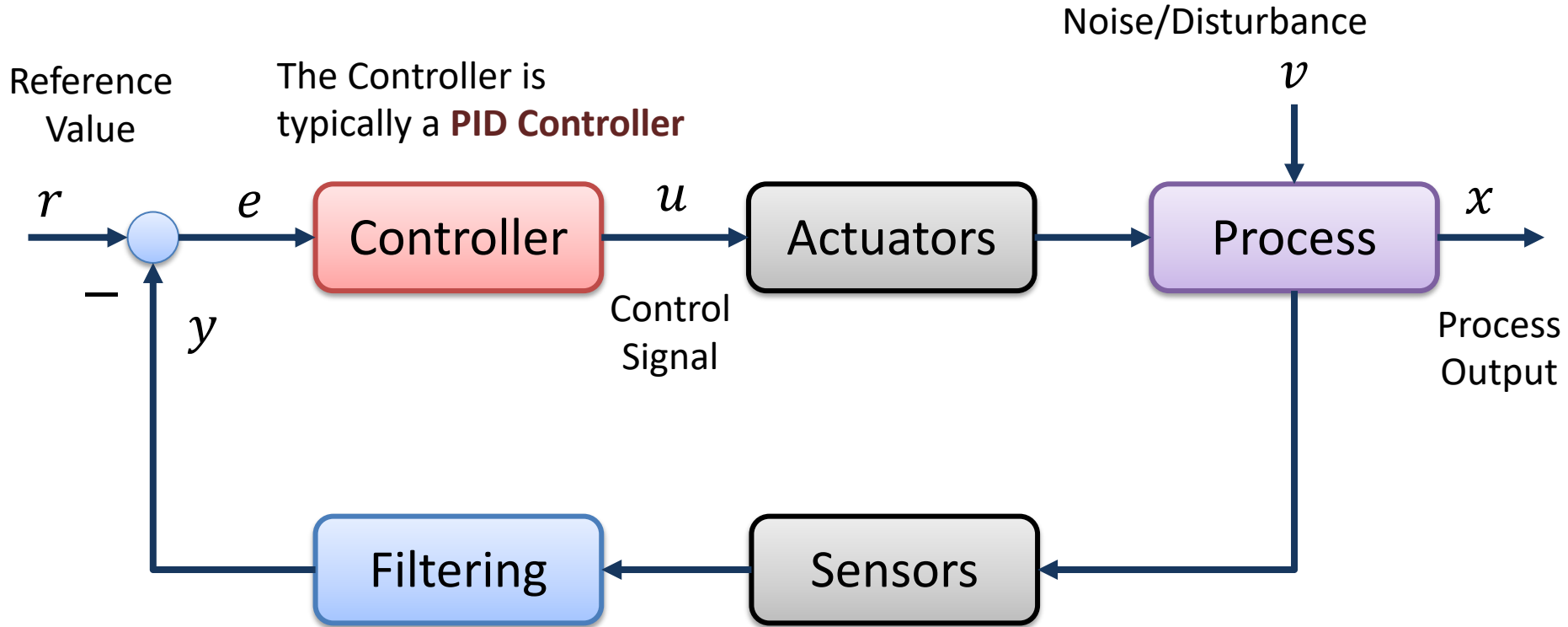
Control System

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

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

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

$\underbrace{\hspace{10em}}$
P

Proportional Gain

K_p

$\underbrace{\hspace{10em}}$
I

Integral Time

T_i

$\underbrace{\hspace{10em}}$
D

Derivative Time

T_d

Tuning Parameters:



LabVIEW Control Design and Simulation Module

Hans-Petter Halvorsen

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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

The LabVIEW Control Design and Simulation Module helps you simulate dynamic systems, design controllers, and deploy control systems to real-time hardware.

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Supported OS ⓘ

Windows ▾

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Version ⓘ

2022 Q3 ▾

Included Editions ⓘ

Full

Application Bitness ⓘ

32-bit ▾

Language ⓘ

English

LabVIEW 2022 Q3 Control Design and Simulation Module

Release Date

7/23/22

Included Versions

2022

> Supported OS

> Language

> Checksum

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File Size

6.46 MB

LabVIEW Control Design and Simulation Module

PID

↑ Search Customize

PID.vi PID Advanced.vi PID Advanced Autotuning.vi PID Autotuning (Temperature).vi PID Autotuning.vi

PID Gain Schedule.vi PID Structure Conversion.vi PID Autotuning Design.vi PID Online Autotuning.vi

PID Setpoint Profile.vi PID Control Input Filter.vi PID Output Rate Limiter.vi PID EGU to Percentage

Simulation

↑ Search Customize

Control & Simulation Loop

Signal Generation Signal Arithmetic Lookup Tables Utilities Graph Utilities

Continuous Linear Systems Nonlinear Systems Discrete Linear Systems Controllers Estimation

Model Hierarchy Implicit Systems Trim & Linearize Optimal Design External Models

Control & Simulation

↑ Search Customize

PID Fuzzy Logic

Simulation Control Design System Identification

Control Design

↑ Search Customize

Model Construction Model Information Model Conversion Model Interconnection

Time Response Frequency Response Dynamic Characteristics Model Reduction

State-Space Model Analysis State Feedback Design Stochastic Systems Solvers

Analytical PID Design Predictive Control Interactive Design Implementation



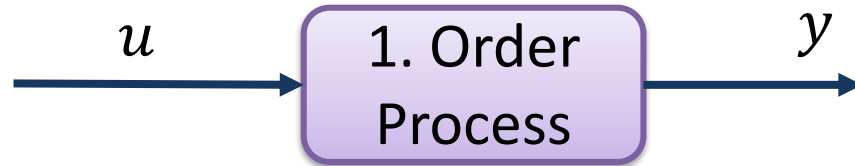
1. Order Process

1. Order System

Differential Equation of a 1. order System:

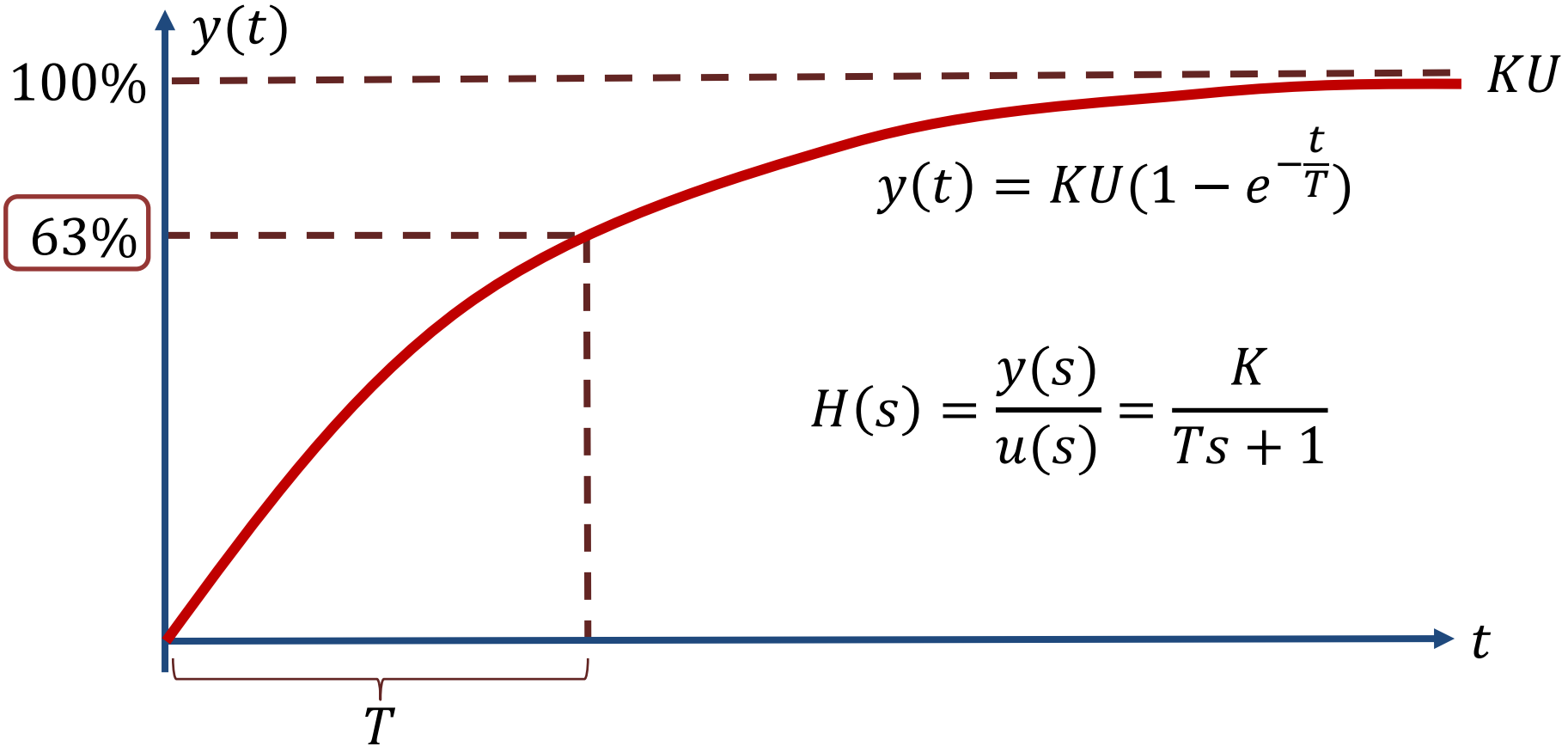
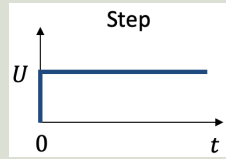
$$\dot{x} = -ax + bu$$

$$y = x$$



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

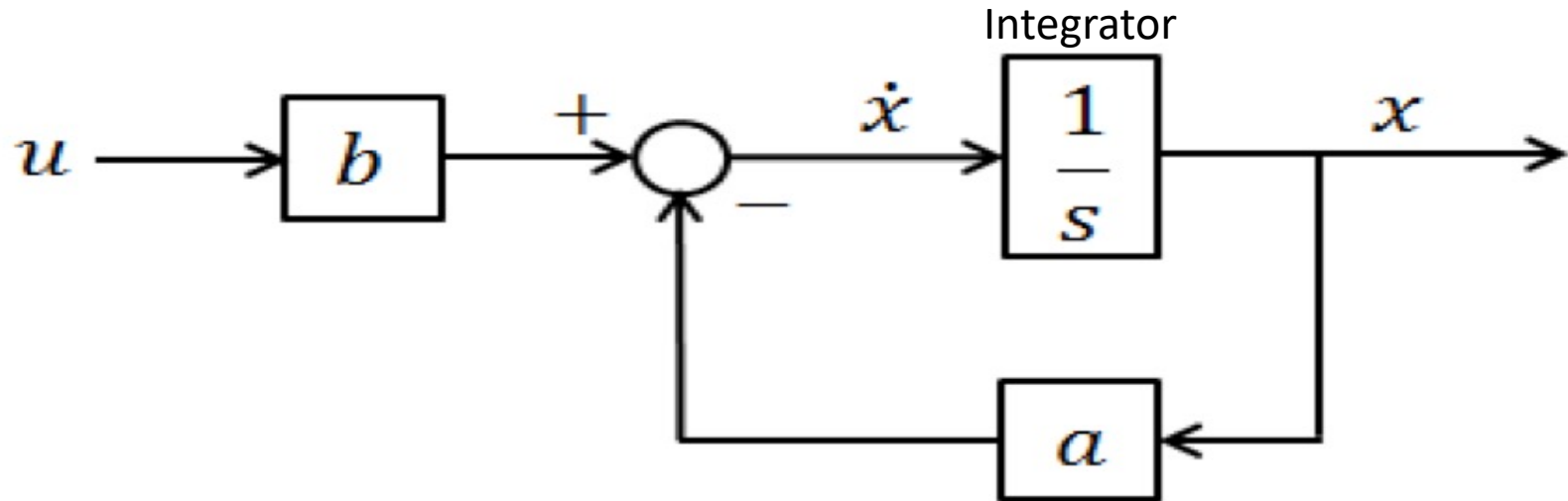


Model – Block Diagram

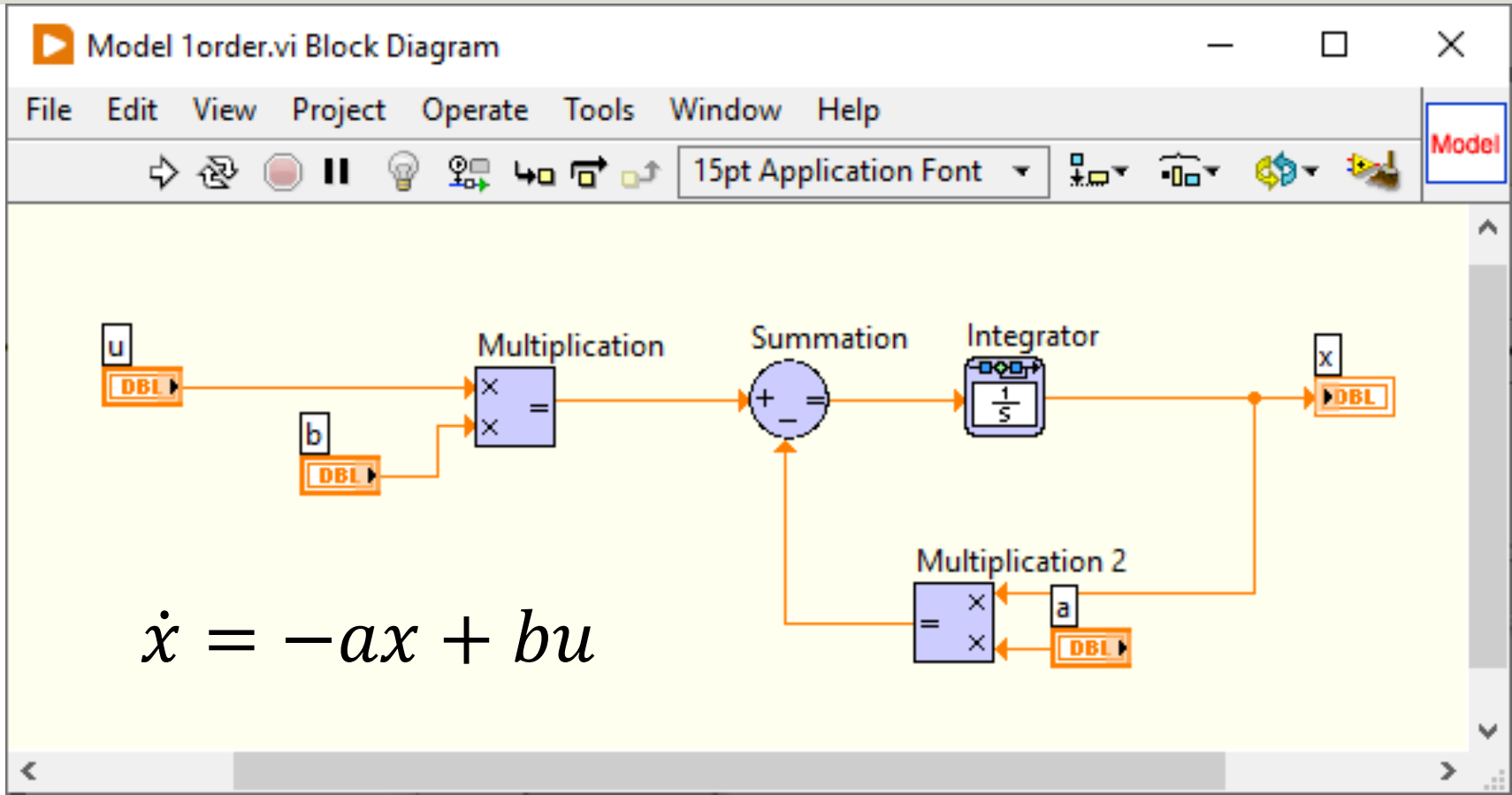
The first order differential equation:

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

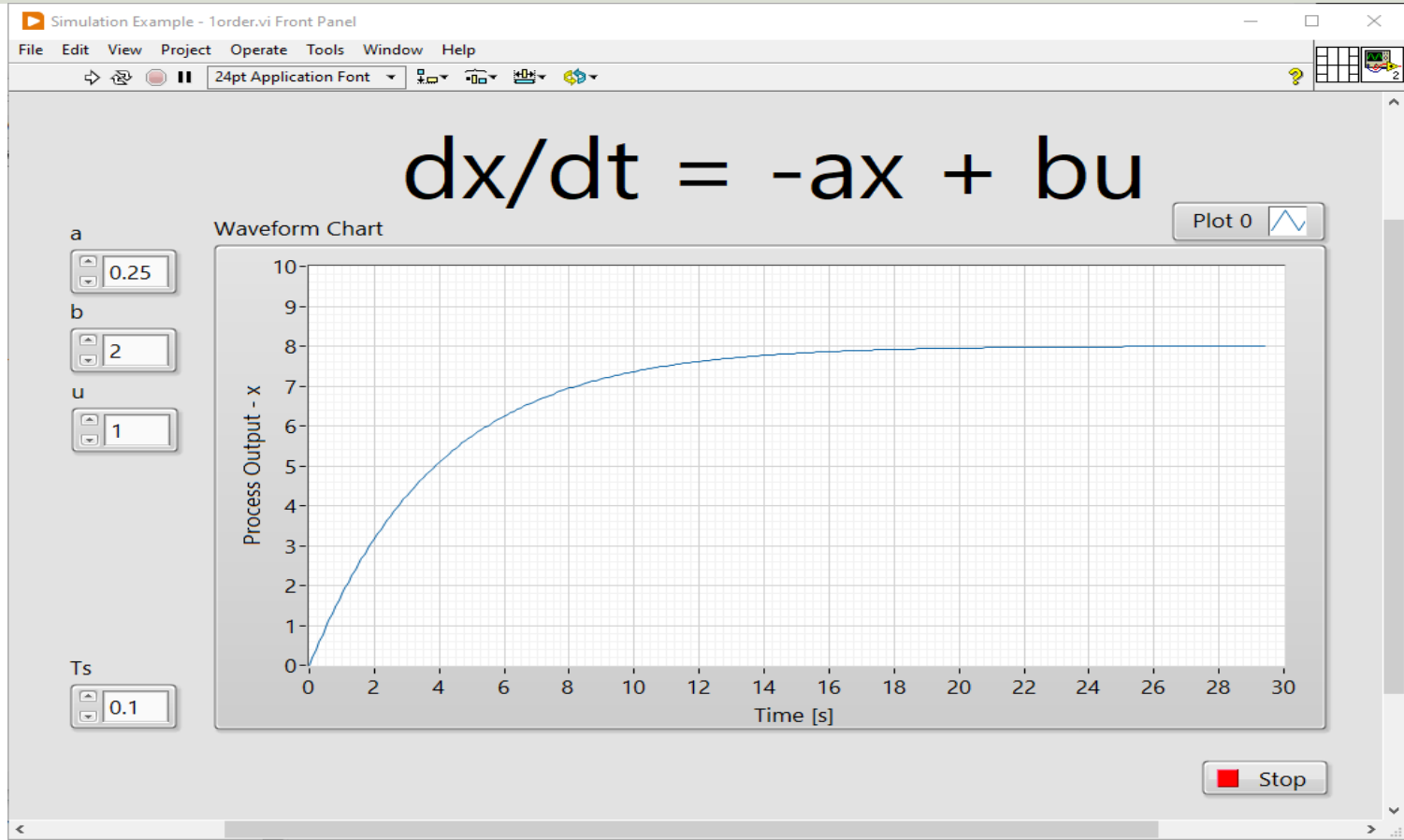
Can be described with the following block diagram model:



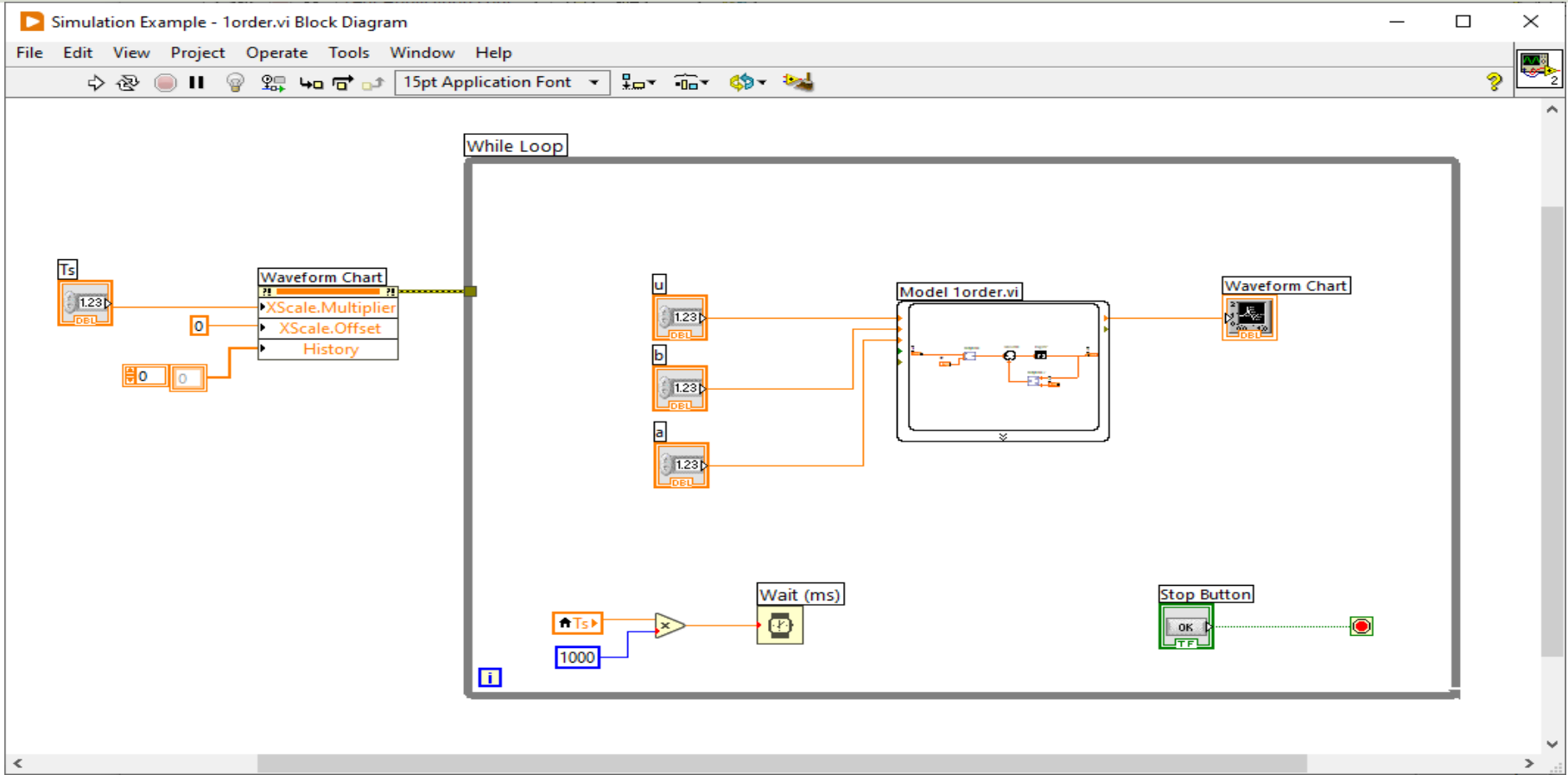
Model in LabVIEW



Simulation in LabVIEW



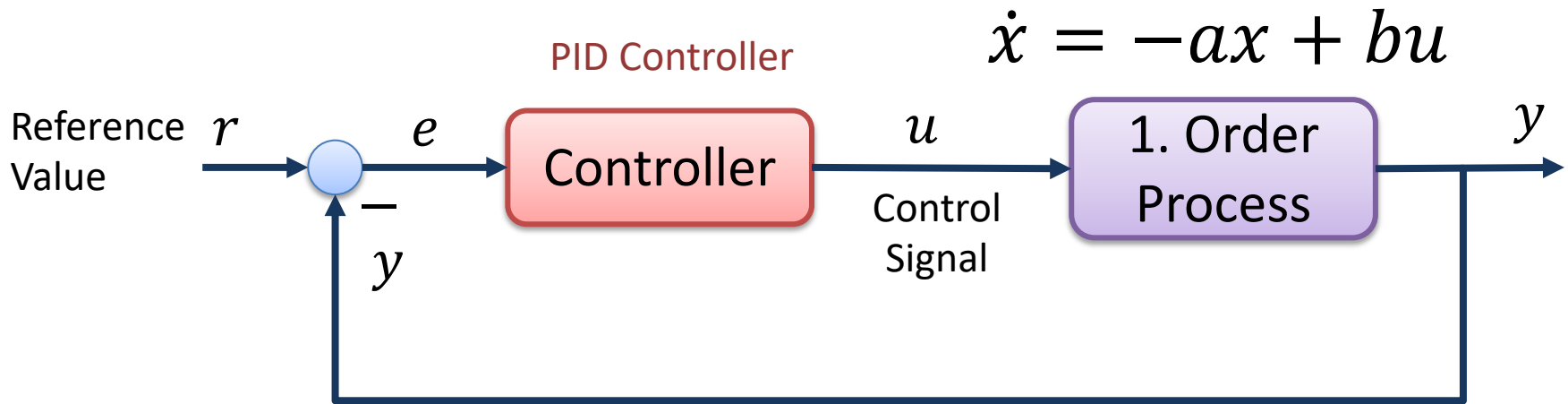
Code



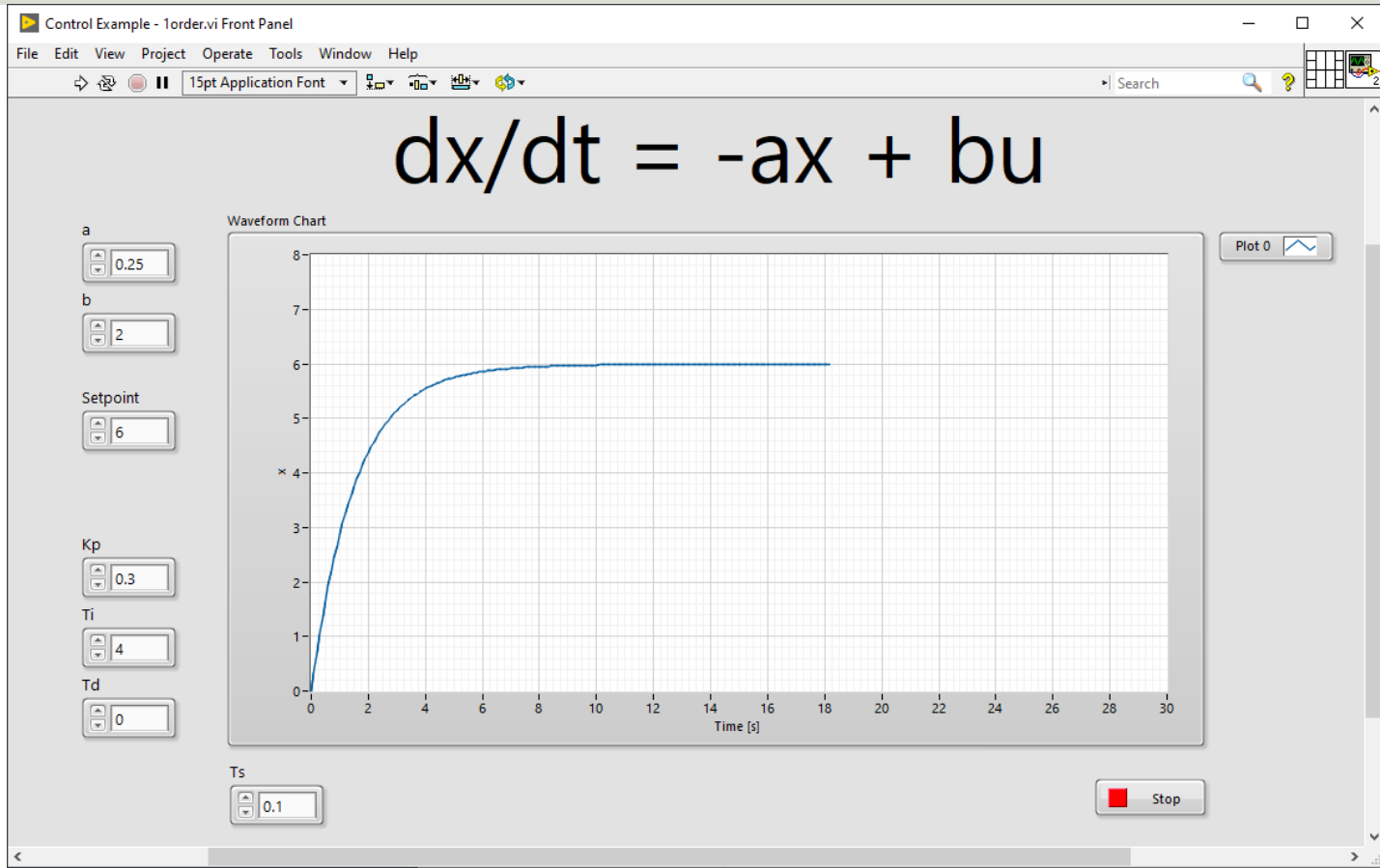


Control System

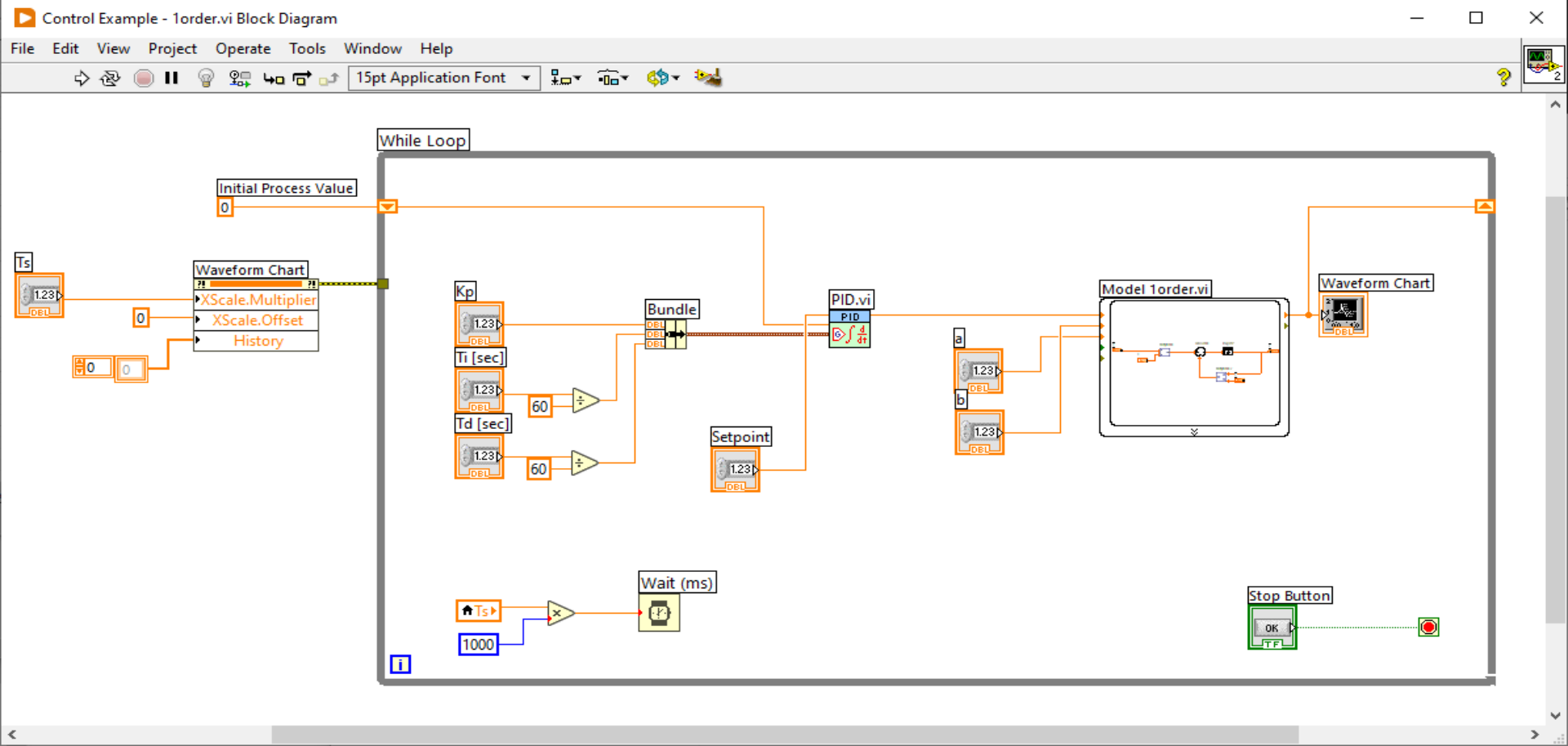
Control System



Control System in LabVIEW



Control System Code



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