Using USB-6008 in Visual Studio/C#

Hans-Petter Halvorsen

Contents

- Visual Studio/C#
- What is DAQ?
- Using USB-6008 in C#
- Analog In
- Analog Out
- Using Timer, Charts, etc.

USB-6008
I/O Module

Software

- Visual Studio/C#
- DAQmx Driver

- DAQmx Driver can be downloaded for free from Internet

DAQ

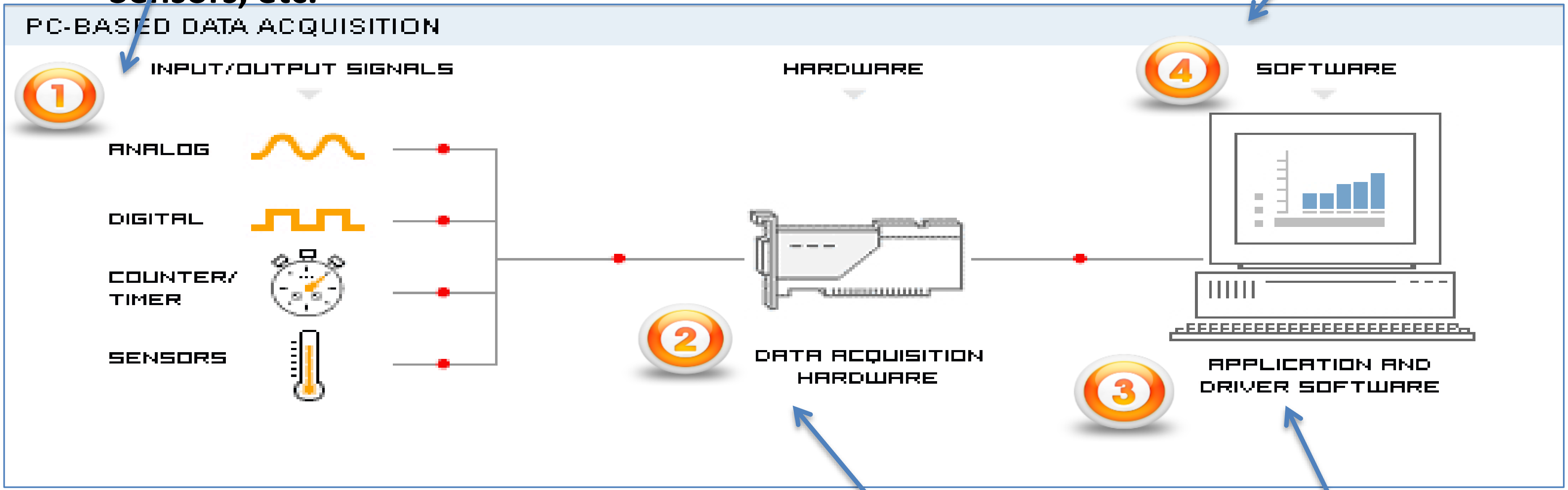
Data Acquisition

Hans-Petter Halvorsen, M.Sc.

DAQ – Data Acquisition

Your App created with C#

Sensors, etc.



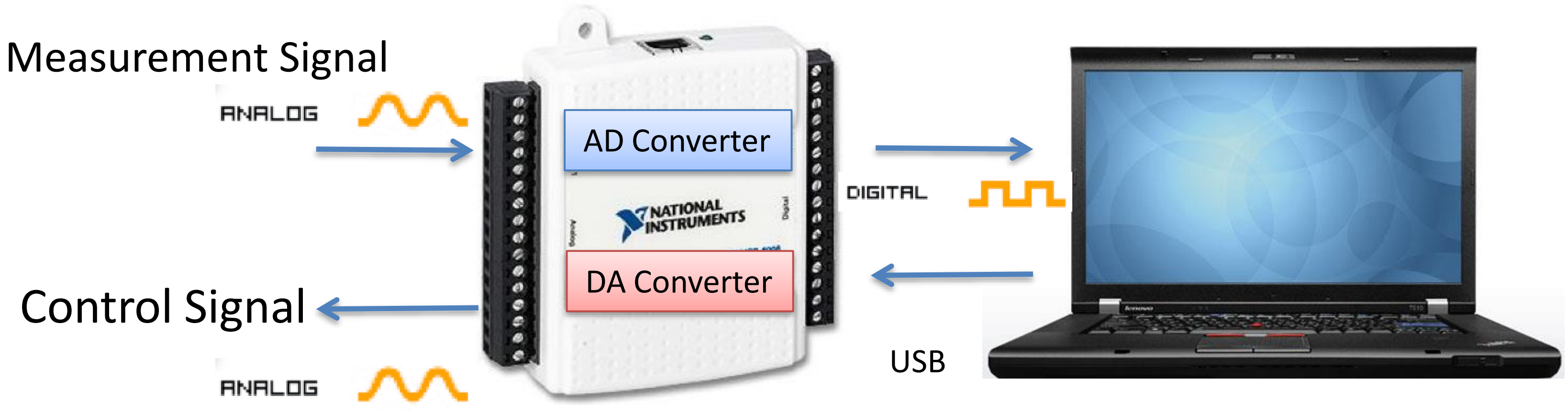
NI USB 6008 DAQ Device

NI DAQmx Driver

A DAQ System consists of 4 parts:

1. Physical input/output signals, sensors
2. DAQ device/hardware
3. Driver software
4. Your software application (Application software)

AD & DA Converters



Measurement Signal

ANALOG

AD Converter

DIGITAL

DA Converter

Control Signal

USB

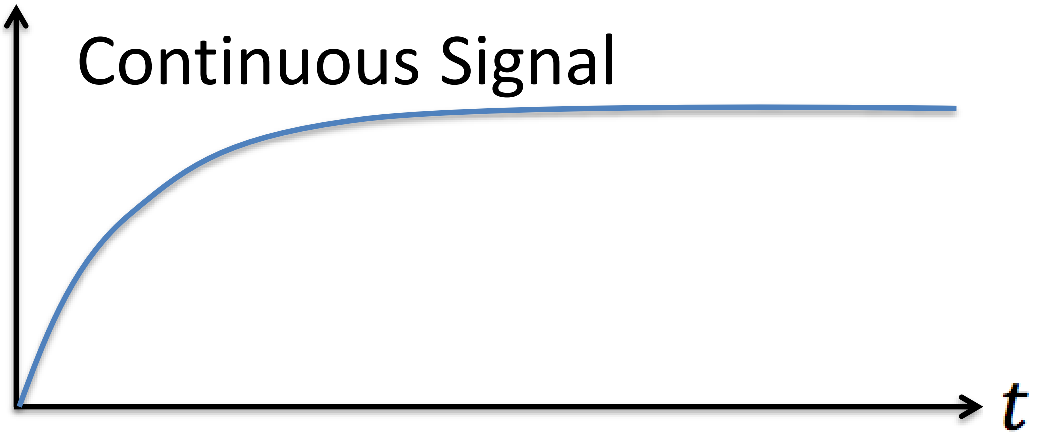
ANALOG

AD – Analog to Digital

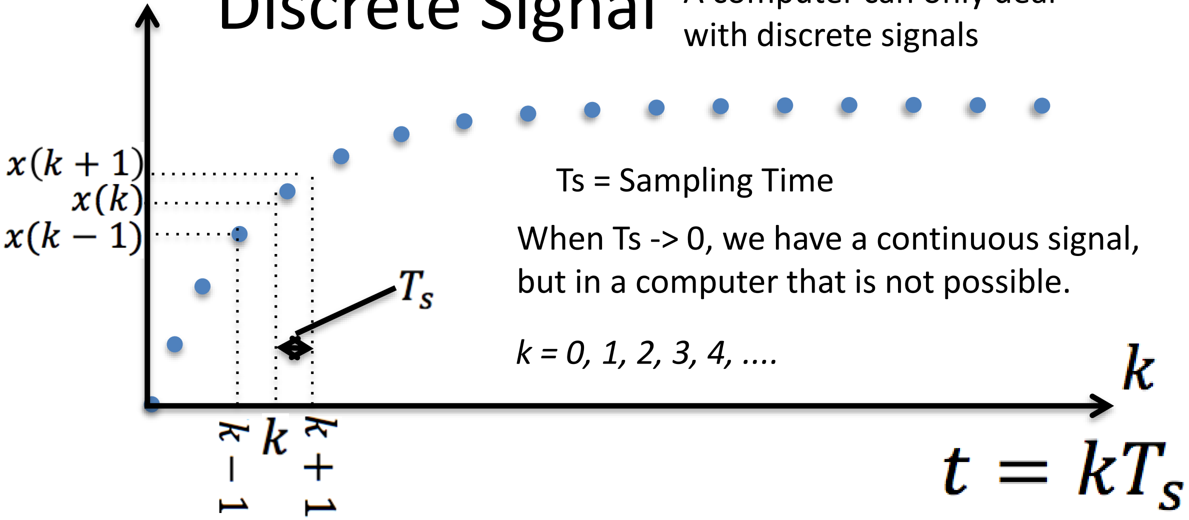
DA – Digital to Analog

All Analog Signals needs to be converted to Digital Signals before the Computer can use them (AD Converter).

Continuous vs. Discrete Signals



Continuous Signal



Discrete Signal

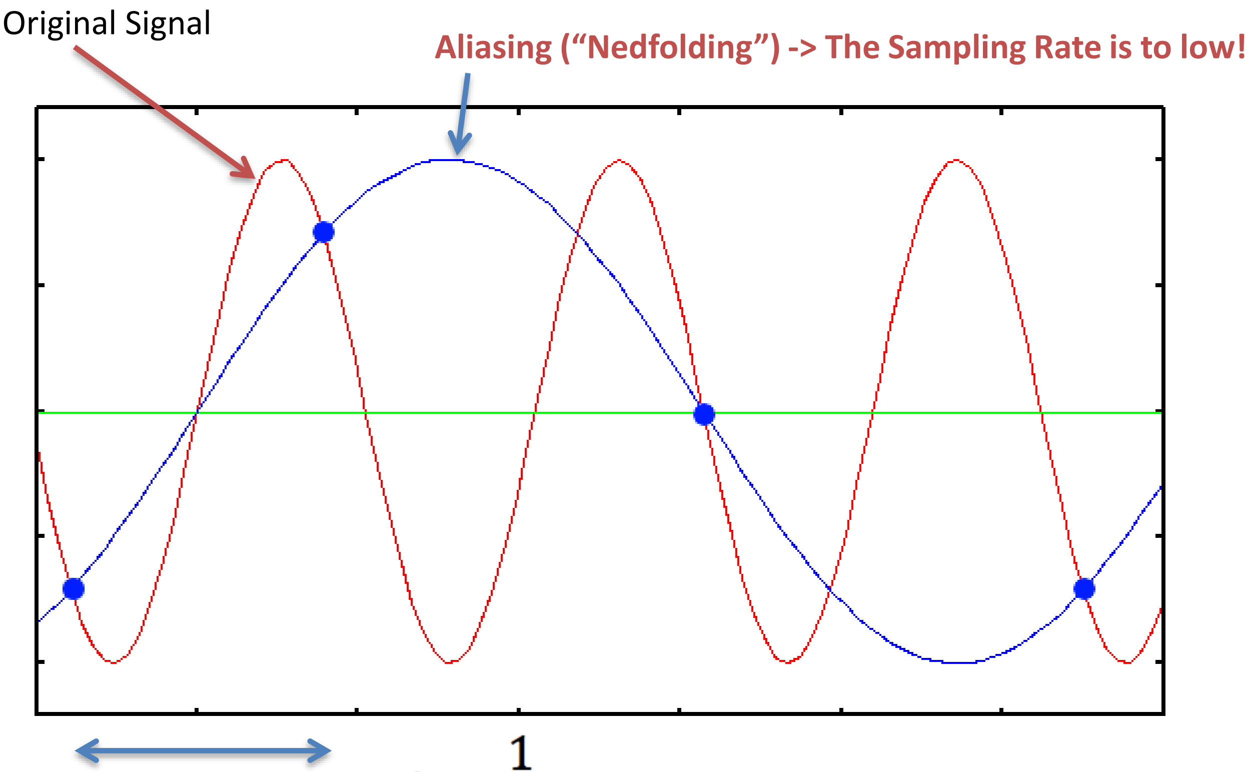
A computer can only deal with discrete signals

Ts = Sampling Time

When Ts -> 0, we have a continuous signal, but in a computer that is not possible.

k = 0, 1, 2, 3, 4, ...

Sampling and Aliasing



Sampling Time

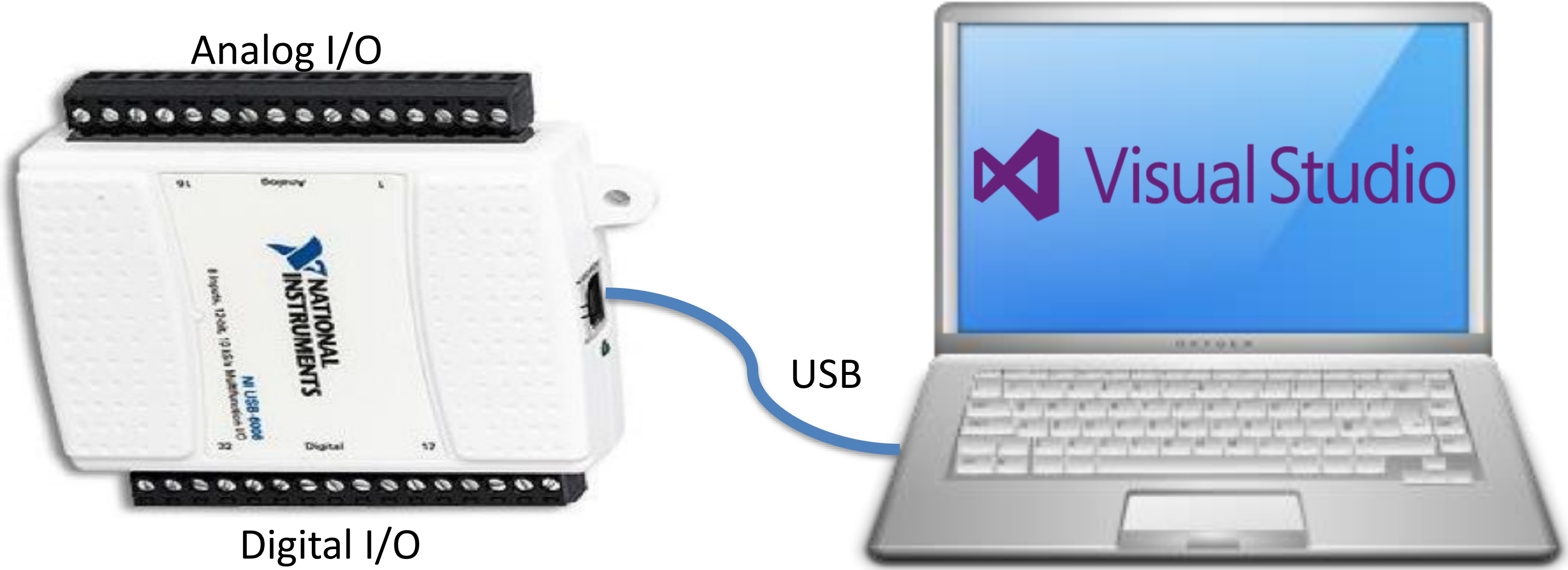
$$f_s = \frac{1}{T_s}$$

Sampling Frequency

USB-6008

Hans-Petter Halvorsen, M.Sc.

How-To use USB-6008 with Visual Studio



USB-6008

Analog I/O

Digital I/O

USB

PC with Visual Studio

NI USB-6008 I/O Module

USB Connection

Note! **DAQmx** Driver is needed!!

Specifications:

-10-10V

- **8 analog inputs**, AI (12-bit, 10 kS/s, -10-10V)
- **2 analog outputs**, AO (12-bit, 150 S/s, 0-5V)
- **12 digital I/O** (DI/DO)
- 32-bit counter

0-5V

4 different types of Signals:

AO – Analog Output

AI – Analog Input

DO – Digital Output

DI – Digital Input

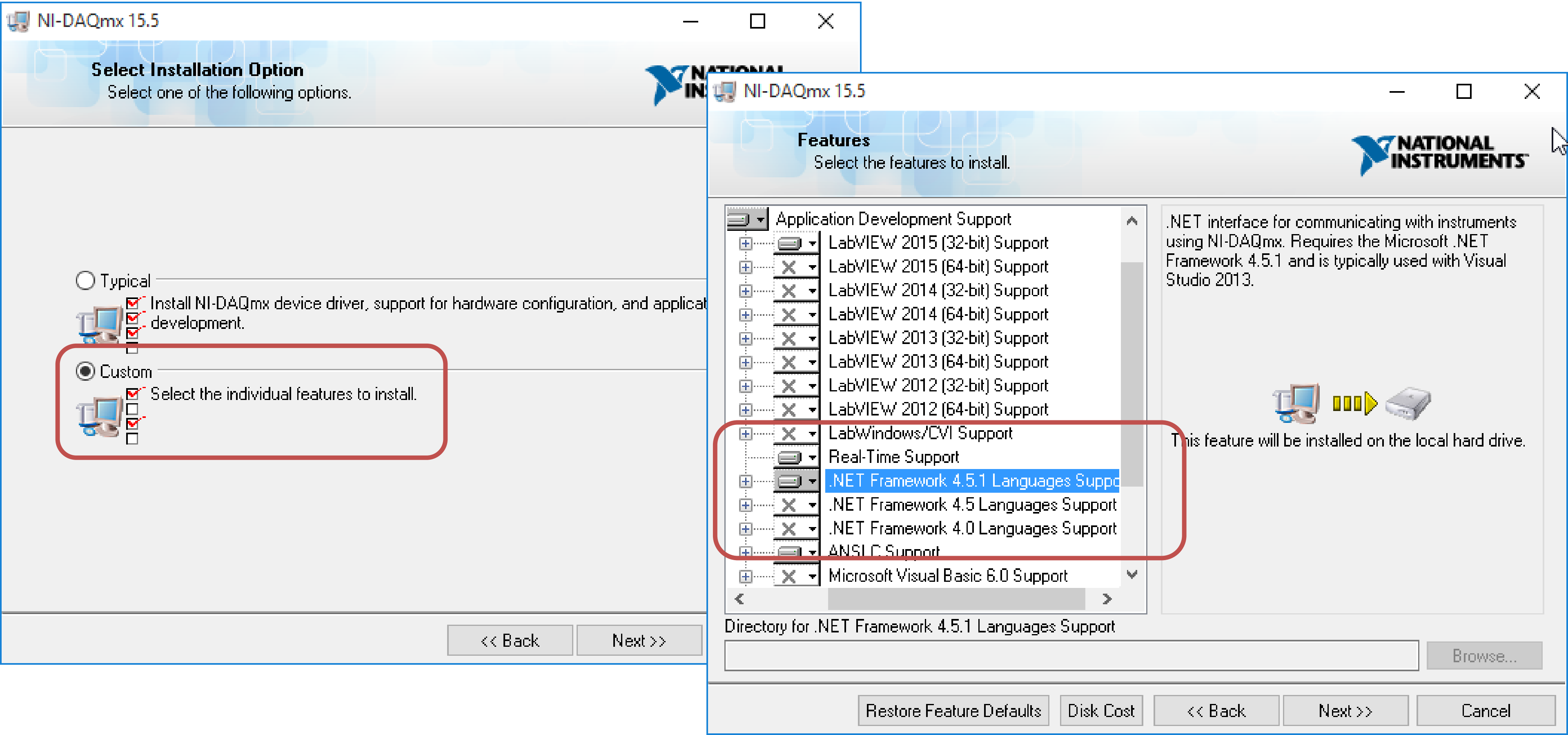
DAQmx Driver

Hans-Petter Halvorsen, M.Sc.

NI DAQmx Driver

- National Instruments provides a native .NET API for NI-DAQmx. This is available as a part of the NI-DAQmx driver
- In order to install the DAQmx API for C#, make sure to select “Custom” and then “.NET Support” when installing the DAQmx driver.
- Next, make sure that you select .NET Framework X.x Support for the version of .NET that your version of Visual Studio is using.

NI DAQmx Driver Installation



NI-DAQmx 15.5

Select Installation Option

Select one of the following options.

○ Typical

Install NI-DAQmx device driver, support for hardware configuration, and applicat development.

● Custom

Select the individual features to install.

NI-DAQmx 15.5

Features

Select the features to install.

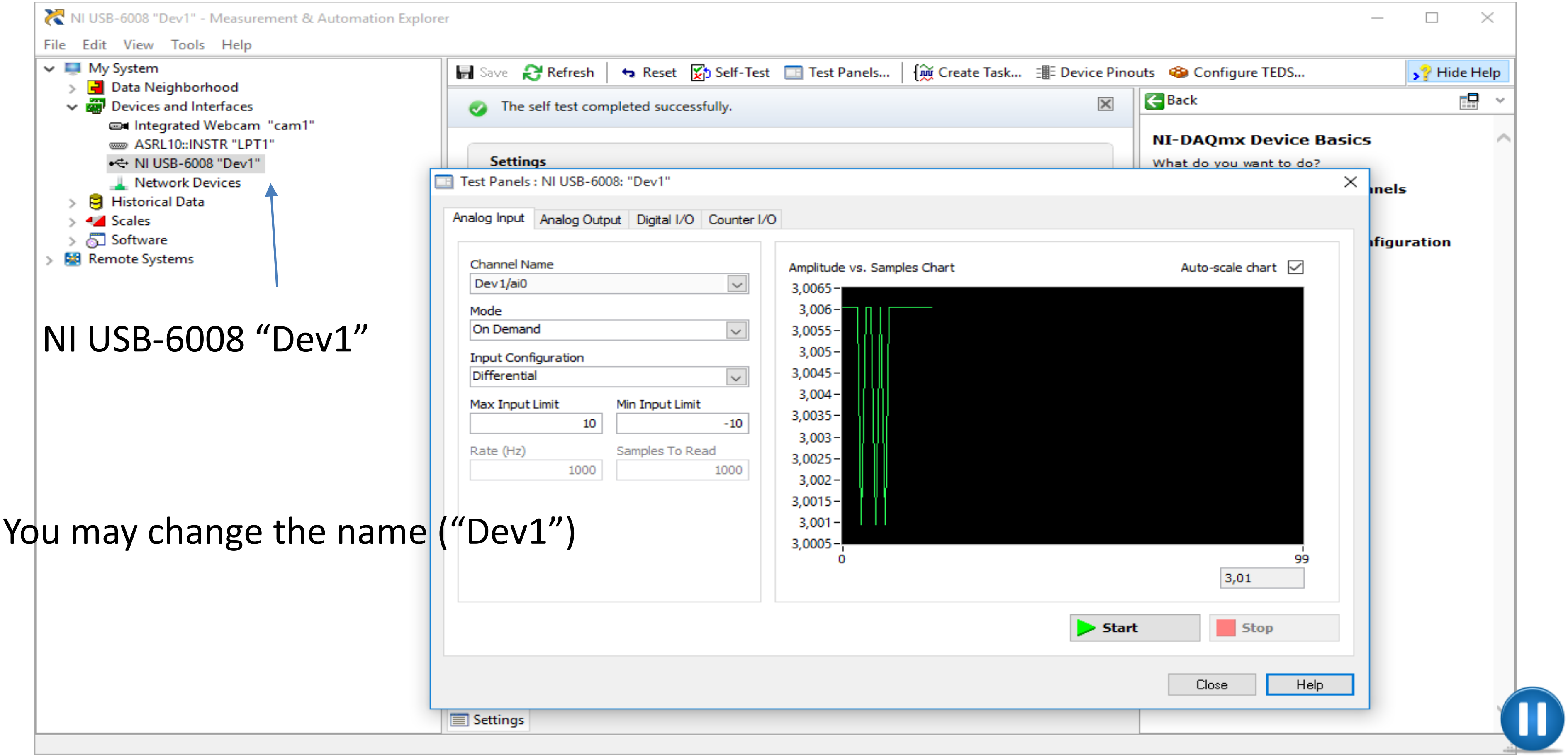
- Application Development Support
  - LabVIEW 2015 (32-bit) Support
  - ☒ LabVIEW 2015 (64-bit) Support
  - ☒ LabVIEW 2014 (32-bit) Support
  - ☒ LabVIEW 2014 (64-bit) Support
  - ☒ LabVIEW 2013 (32-bit) Support
  - ☒ LabVIEW 2013 (64-bit) Support
  - ☒ LabVIEW 2012 (32-bit) Support
  - ☒ LabVIEW 2012 (64-bit) Support
  - ☒ LabWindows/CVI Support
  - Real-Time Support
  - .NET Framework 4.5.1 Languages Suppo
  - ☒ .NET Framework 4.5 Languages Support
  - ☒ .NET Framework 4.0 Languages Support
  - ANSI C Support
  - ☒ Microsoft Visual Basic 6.0 Support

.NET interface for communicating with instruments using NI-DAQmx. Requires the Microsoft .NET Framework 4.5.1 and is typically used with Visual Studio 2013.

This feature will be installed on the local hard drive.

Directory for .NET Framework 4.5.1 Languages Support

MAX – Measurement & Automation Explorer



NI USB-6008 "Dev1" - Measurement & Automation Explorer

The self test completed successfully.

Test Panels : NI USB-6008: "Dev1"

Channel Name: Dev1/ai0

Mode: On Demand

Input Configuration: Differential

Max Input Limit: 10

Min Input Limit: -10

Rate (Hz): 1000

Samples To Read: 1000

Auto-scale chart ☑

NI-DAQmx Device Basics

What do you want to do?

NI USB-6008 "Dev1"

You may change the name ("Dev1")

C# Examples

Analog In

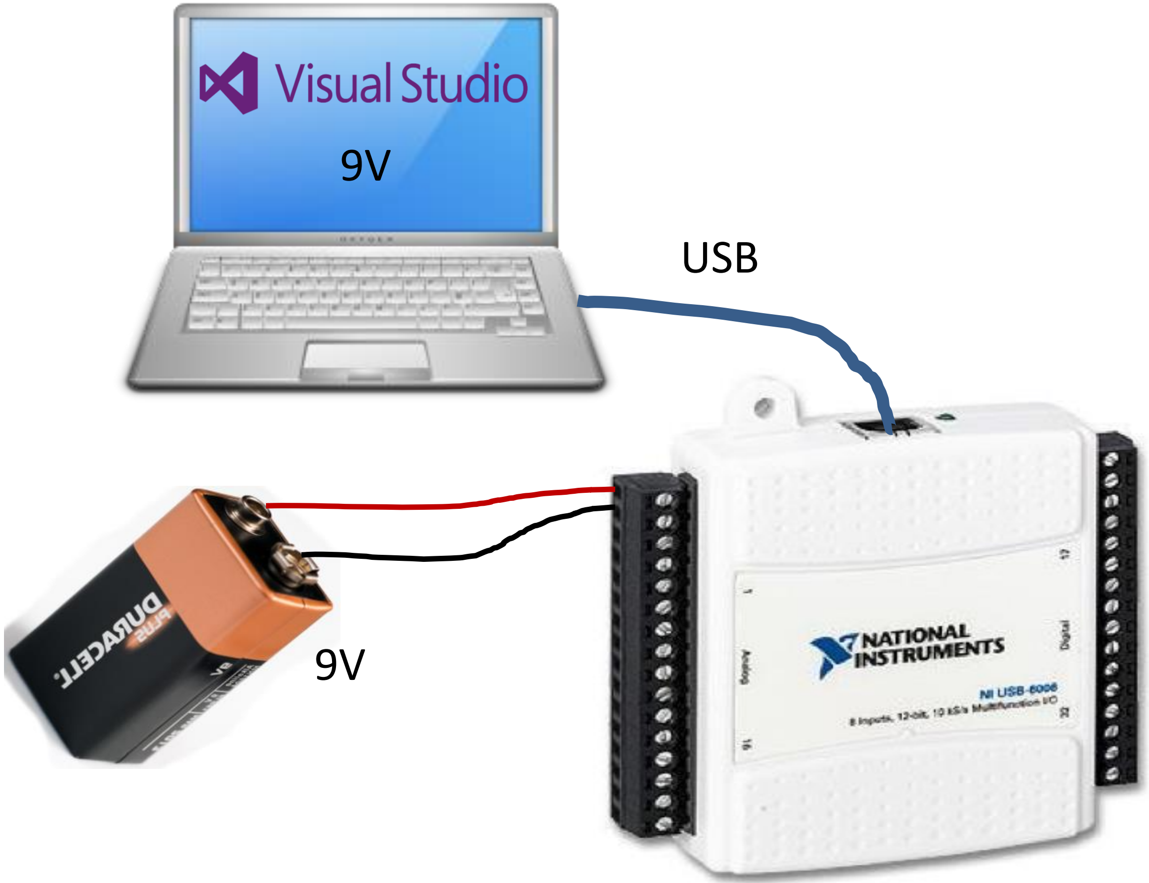
Hans-Petter Halvorsen, M.Sc.

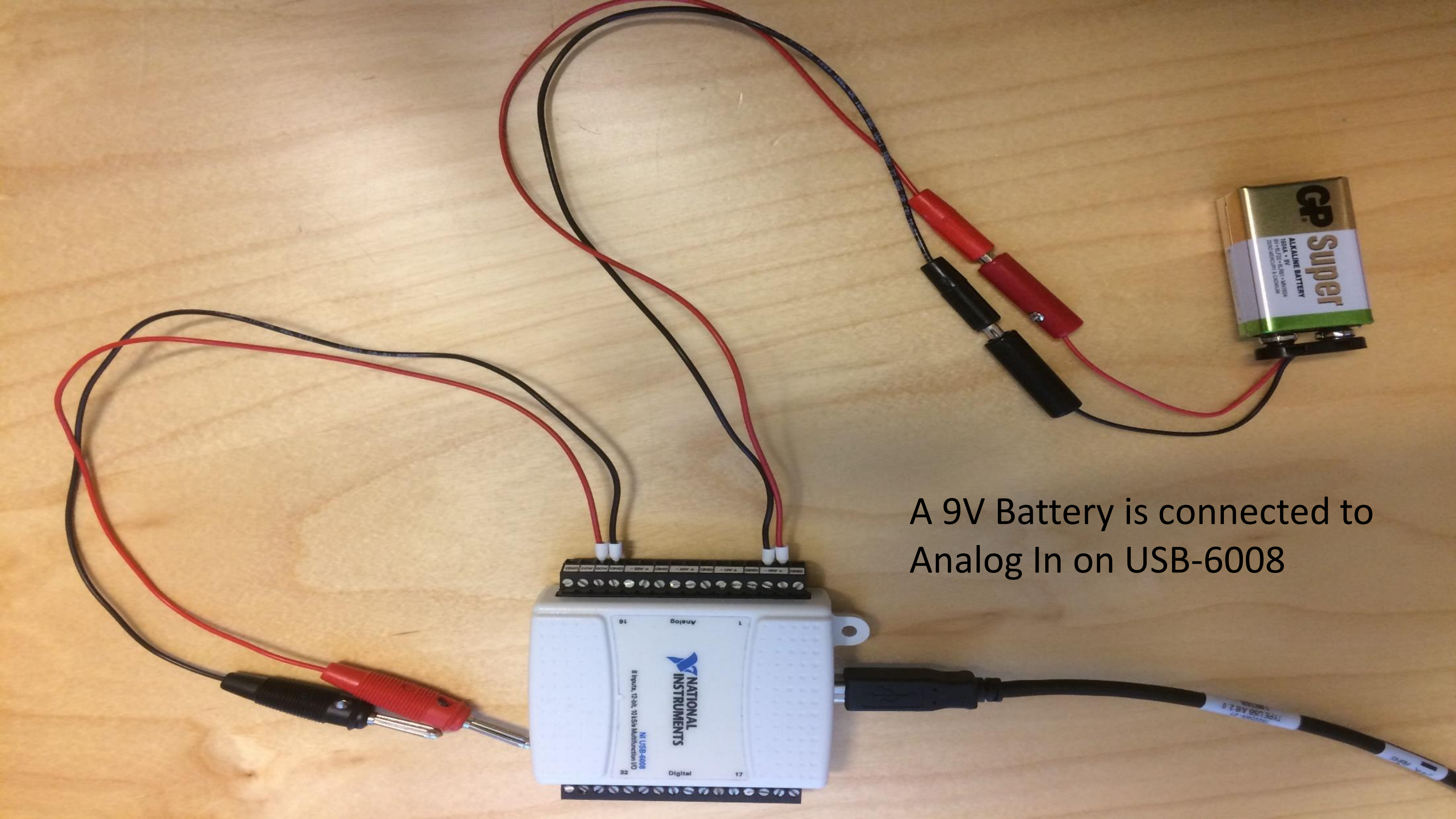
Read Analog Values

We will read the voltage values on different batteries

Read Analog Signals with USB-6008

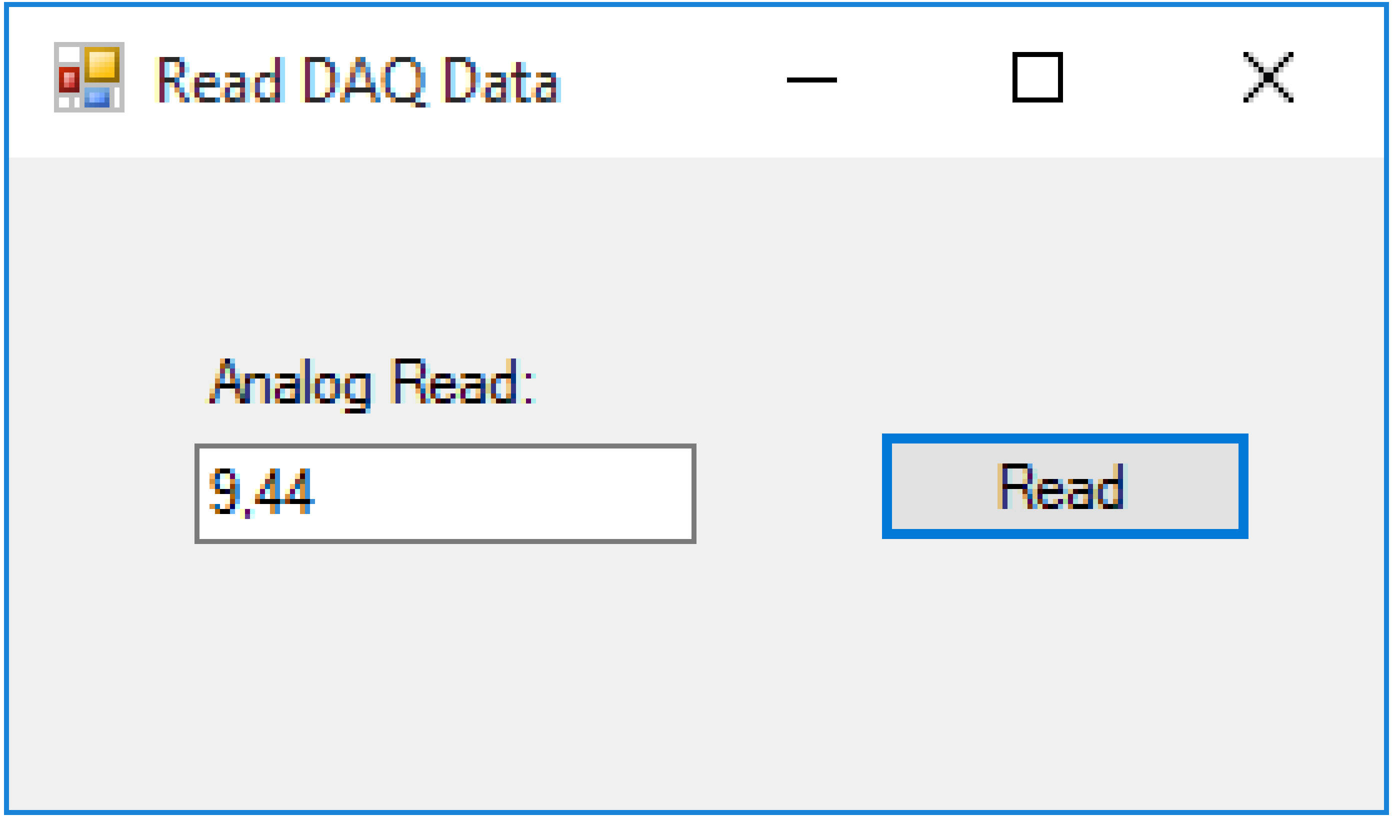
Multimeter





A 9V Battery is connected to Analog In on USB-6008

Read from USB-6008 DAQ Device



Analog Read:

9,44

Simple **DAQ** in C# with DAQmx

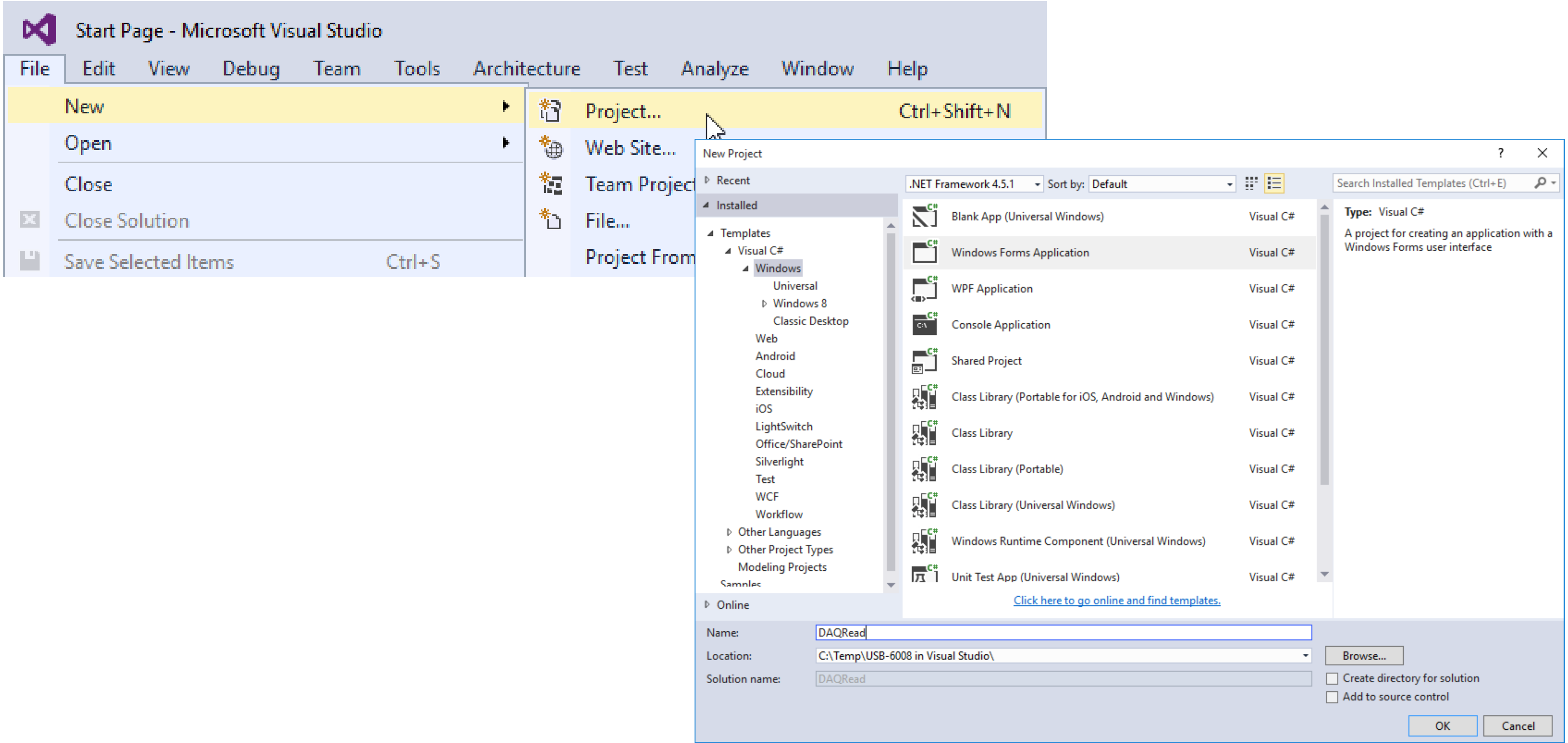
Example

```
using NationalInstruments.DAQmx;
…
Task analogInTask = new Task();
AIChannel myAIChannel;

myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
              "dev1/ai0",
              "myAIChannel",
              AITerminalConfiguration.Differential,
              0,
              5,
              AIVoltageUnits.Volts
              );

AnalogSingleChannelReader reader = new
        AnalogSingleChannelReader(analogInTask.Stream);

double analogDataIn = reader.ReadSingleSample();

txtAnalogIn.Text = analogDataIn.ToString("0.00");
```

Analog In Example

```
using NationalInstruments.DAQmx;
…
Task analogInTask = new Task();
AIChannel myAIChannel;

myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
              "dev1/ai0",
              "myAIChannel",
              AITerminalConfiguration.Differential,
              0,
              5,
              AIVoltageUnits.Volts
              );

AnalogSingleChannelReader reader = new
       AnalogSingleChannelReader(analogInTask.Stream);

double analogDataIn = reader.ReadSingleSample();

txtAnalogIn.Text = analogDataIn.ToString("0.00");
```

WinForm App


Start Page - Microsoft Visual Studio
File
Edit
View
Debug
Team
Tools
Architecture
Test
Analyze
Window
Help
New
Open
Close
Close Solution
Save Selected Items Ctrl+S
Project... Ctrl+Shift+N
Web Site...
Team Project
File...
Project From
New Project
?
Recent
Installed
Templates
Visual C#
Windows
Universal
Windows 8
Classic Desktop
Web
Android
Cloud
Extensibility
iOS
LightSwitch
Office/SharePoint
Silverlight
Test
WCF
Workflow
Other Languages
Other Project Types
Modeling Projects
Samples
Online
Search Installed Templates (Ctrl+E)
Blank App (Universal Windows) Visual C#
Windows Forms Application Visual C#
WPF Application Visual C#
Console Application Visual C#
Shared Project Visual C#
Class Library (Portable for iOS, Android and Windows) Visual C#
Class Library Visual C#
Class Library (Portable) Visual C#
Class Library (Universal Windows) Visual C#
Windows Runtime Component (Universal Windows) Visual C#
Unit Test App (Universal Windows) Visual C#
Click here to go online and find templates.
Browse...
OK
Cancel

.NET Framework 4.5.1

Sort by: Default

Type: Visual C#

A project for creating an application with a Windows Forms user interface

Name: DAQRead

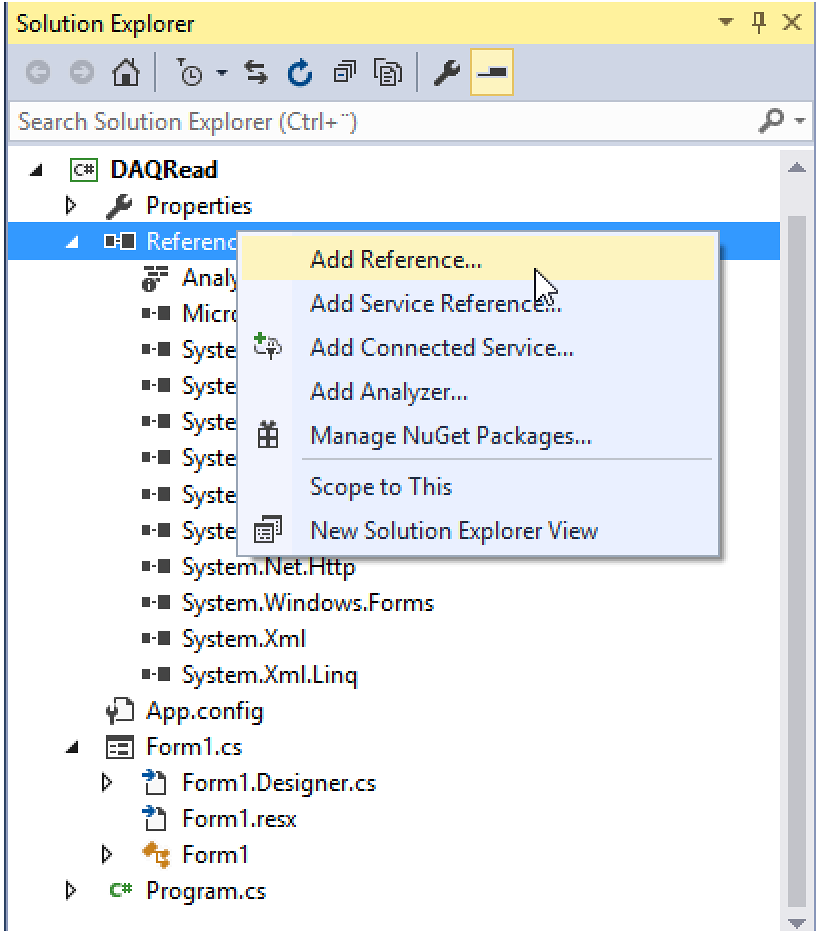
Location: C:\Temp\USB-6008 in Visual Studio\

Solution name: DAQRead

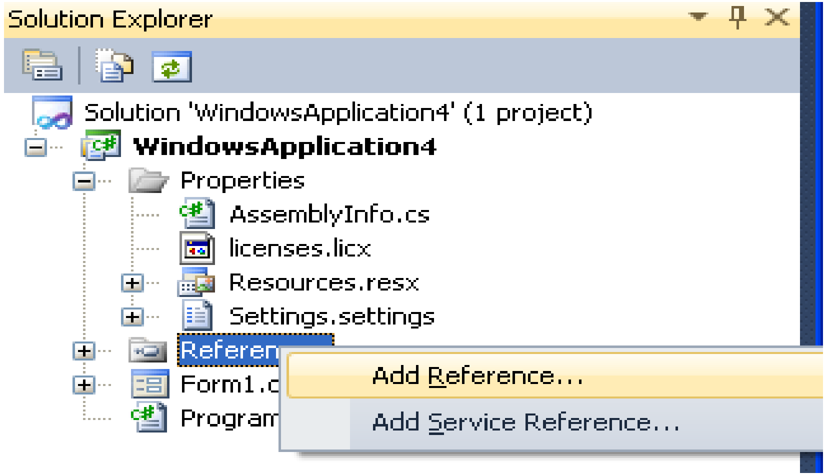
☐ Create directory for solution

☐ Add to source control

Add Assembly References



Add References to the DAQmx Driver in Visual Studio



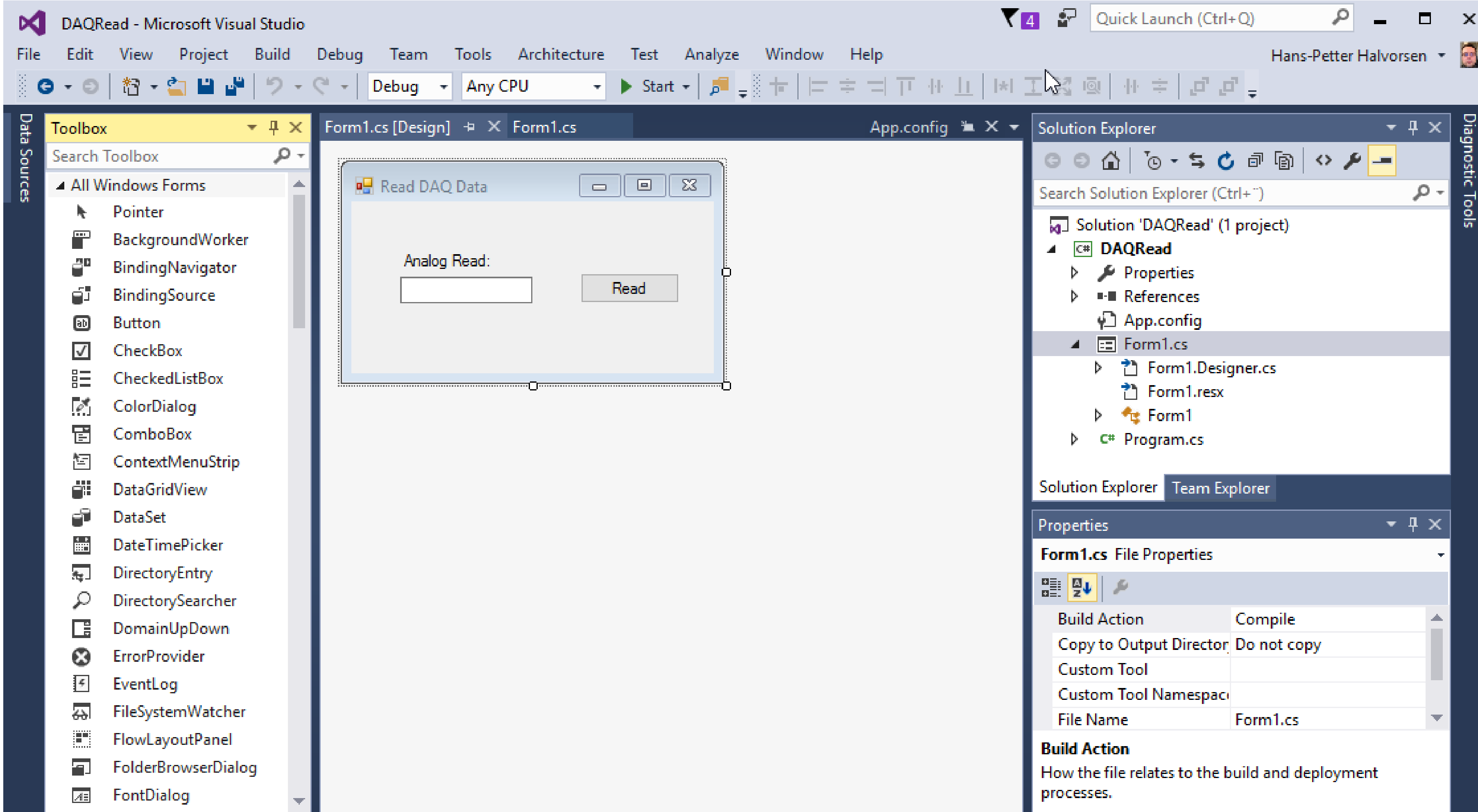
Select «Browse» and Find `NationalInstruments.DAQmx.dll`

C:\Program Files (x86)\National Instruments\...

We also need to add the following Namespaces:

```
NationalInstruments.DAQmx.dll
```

```
using NationalInstruments.DAQmx;
```



Form1.cs File Properties

Build Action	Compile
Copy to Output Director	Do not copy
Custom Tool	
Custom Tool Namespac	
File Name	Form1.cs

Build Action

How the file relates to the build and deployment processes.

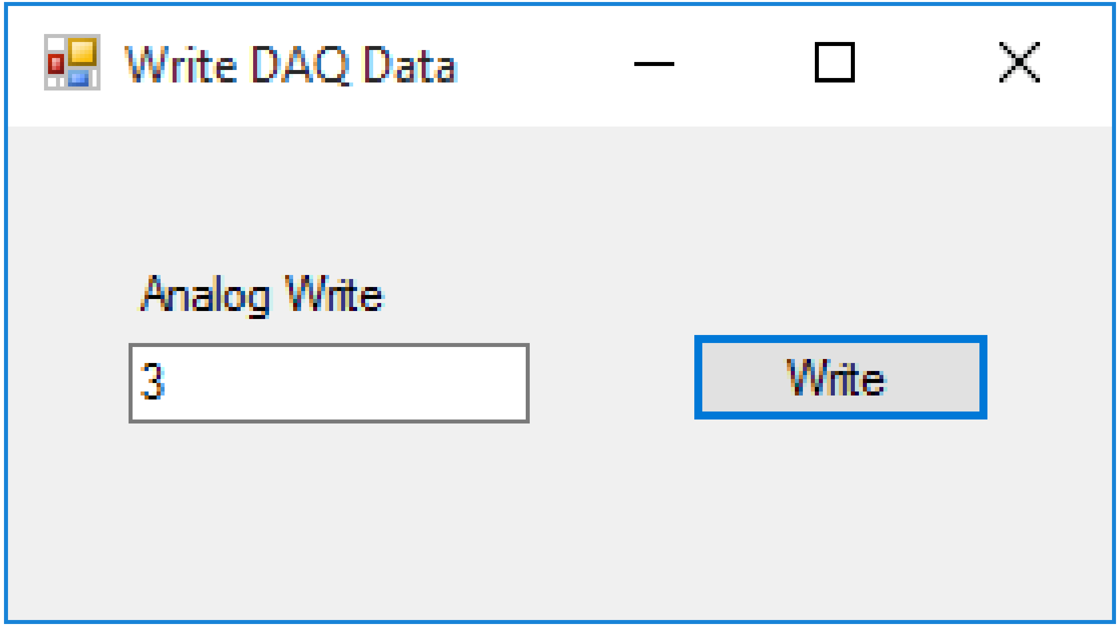
```
using System;
using System.Windows.Forms;
using NationalInstruments.DAQmx;

namespace DAQRead
{
    public partial class Form1 : Form
    {
        public Form1()
        {
            InitializeComponent();
        }

        private void btnRead_Click(object sender, EventArgs e)
        {
            Task analogInTask = new Task();

            AIChannel myAIChannel;

            myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
                "dev1/ai0",
                "myAIChannel",
                AITerminalConfiguration.Differential,
                0,
                10,
                AIVoltageUnits.Volts
                );

            AnalogSingleChannelReader reader = new AnalogSingleChannelReader(analogInTask.Stream);

            double analogDataIn = reader.ReadSingleSample();

            txtDaqValue.Text = analogDataIn.ToString("0.00");

        }
    }
}
```

C# Examples

Analog Out

Hans-Petter Halvorsen, M.Sc.

Write to USB-6008 DAQ Device



Analog Write

3

Simple **DAQ** in C# with DAQmx

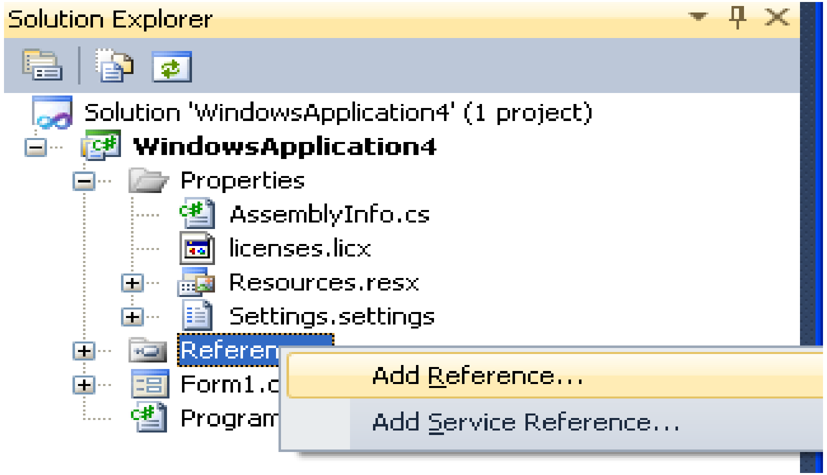
Example

```
using NationalInstruments.DAQmx;
…
Task analogOutTask = new Task();
AOChannel myAOChannel;

myAOChannel = analogOutTask.AOChannels.CreateVoltageChannel(
              "dev1/ao0",
              "myAOChannel",
              0,
              5,
              AOVoltageUnits.Volts
              );

AnalogSingleChannelWriter writer = new
       AnalogSingleChannelWriter(analogOutTask.Stream);

double analogDataOut;
analogDataOut = Convert.ToDouble(txtAnalogOut.Text);

writer.WriteSingleSample(true, analogDataOut);
```

Analog Out Example

```
using NationalInstruments.DAQmx;
…
Task analogOutTask = new Task();
AOChannel myAOChannel;

myAOChannel = analogOutTask.AOChannels.CreateVoltageChannel(
              "dev1/ao0",
              "myAOChannel",
              0,
              5,
              AOVoltageUnits.Volts
              );

AnalogSingleChannelWriter writer = new
       AnalogSingleChannelWriter(analogOutTask.Stream);

double analogDataOut;
analogDataOut = Convert.ToDouble(txtAnalogOut.Text);

writer.WriteSingleSample(true, analogDataOut);
```

Add References to the DAQmx Driver in Visual Studio



Select «Browse» and Find `NationalInstruments.DAQmx.dll`

C:\Program Files (x86)\National Instruments\...

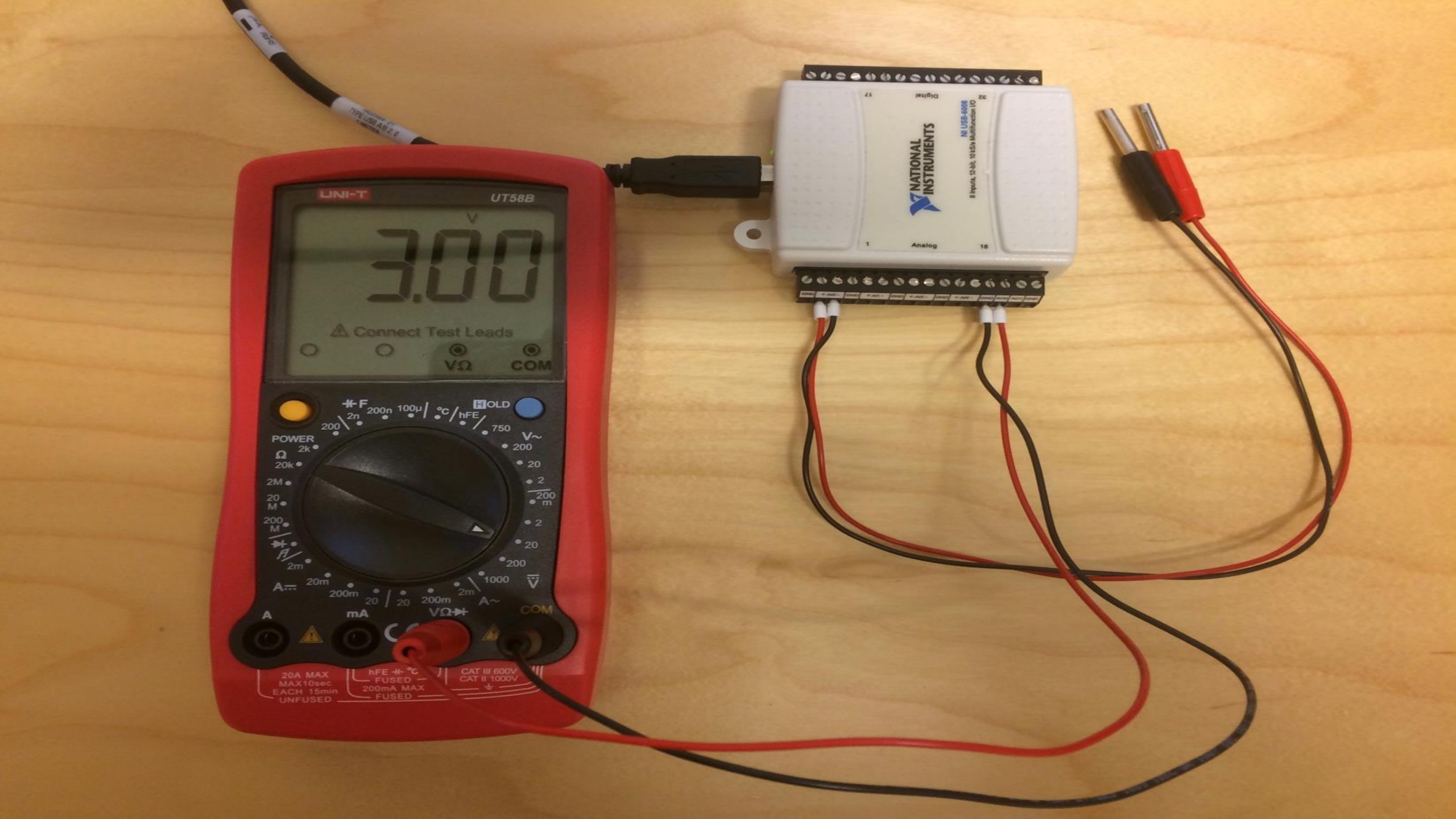
We also need to add the following Namespaces:

```
NationalInstruments.DAQmx.dll
```

```
using NationalInstruments.DAQmx;
```

DAQ in C# with DAQmx – Analog Out

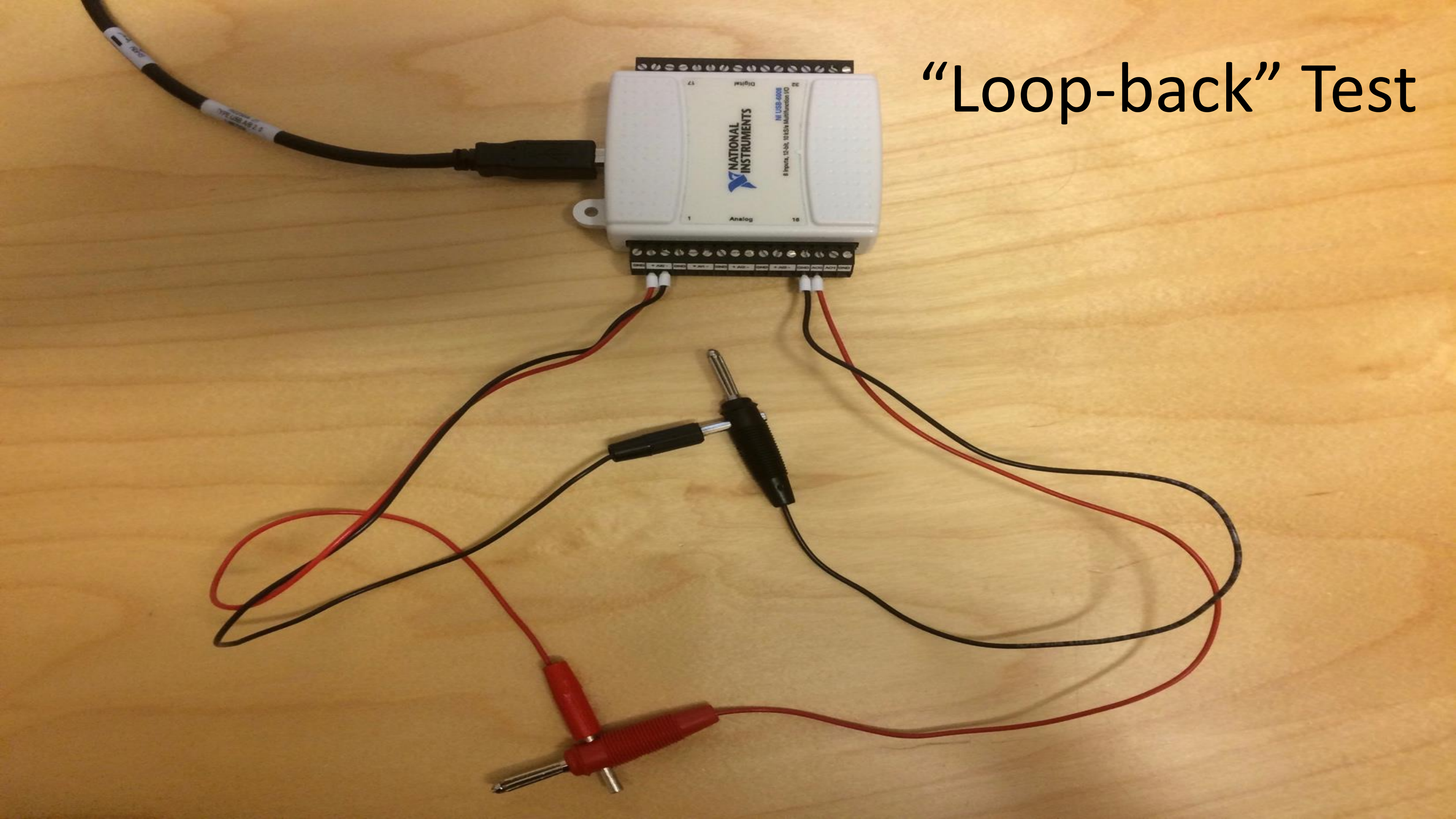
```
private void btnWriteAnalogOut_Click(object sender, EventArgs e)
       {
           Task analogOutTask = new Task();

           AOChannel myAOChannel;

           myAOChannel = analogOutTask.AOChannels.CreateVoltageChannel(
               "dev1/ao0",
               "myAOChannel",
               0,
               5,
               AOVoltageUnits.Volts
               );

           AnalogSingleChannelWriter writer = new
            AnalogSingleChannelWriter(analogOutTask.Stream);

           double analogDataOut;
           analogDataOut = Convert.ToDouble(txtAnalogOut.Text);

           writer.WriteSingleSample(true, analogDataOut);
       }
```


UNI-T
UT58B
V
3.00
Connect Test Leads
VΩ
COM
POWER
HOLD
Ω
2k
20k
2M
20 M
200 M
2m
20m
200m
20
200m
2m
1000
750
200
20
2
200 m
2
20
200
200n
100μ
°C
hFE
V~
A~
A
mA
VΩ
COM
20A MAX
MAX10sec
EACH 15min
UNFUSED
hFE °C
FUSED
200mA MAX
FUSED
CAT III 600V
CAT II 1000V
NATIONAL INSTRUMENTS
NI USB-6008
8 inputs, 12-bit, 10 kS/s Multifunction I/O
Digital
17
32
Analog
1
16

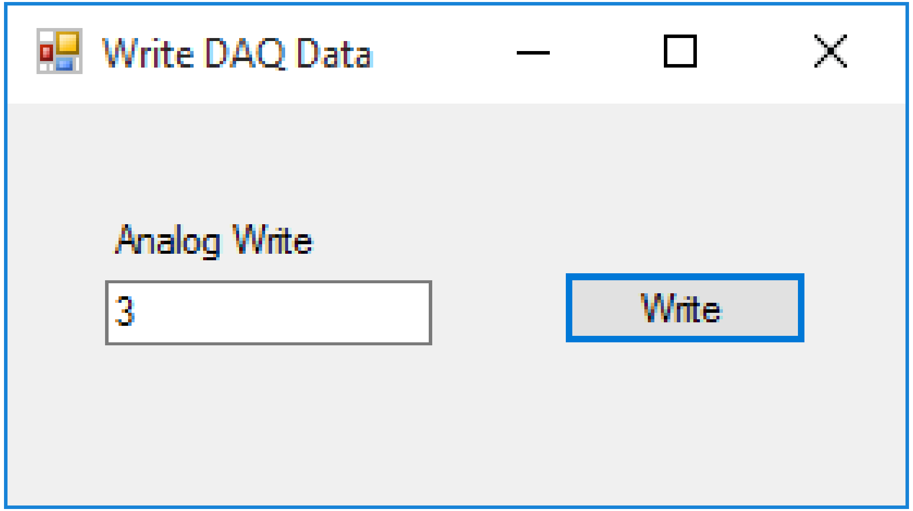
Analog Out + Analog In

Hans-Petter Halvorsen, M.Sc.

“Loop-back” Test

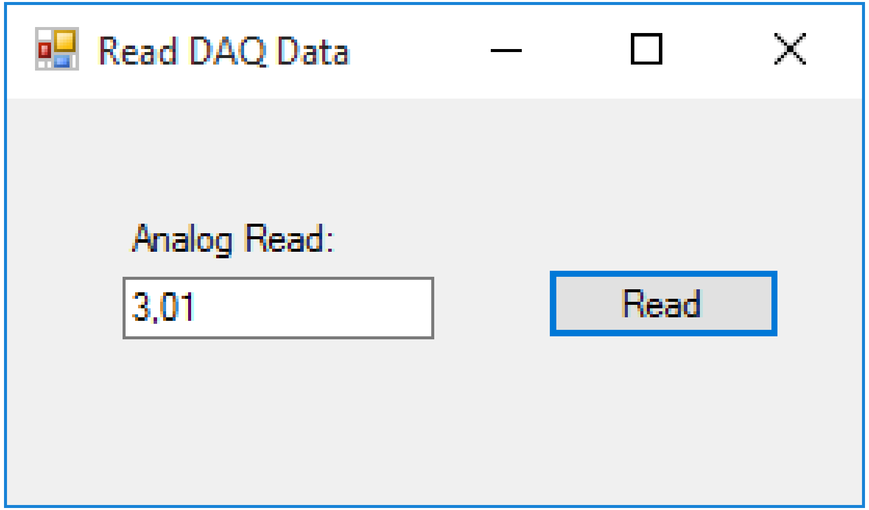


Write/Read Data using USB-6008



Analog Write

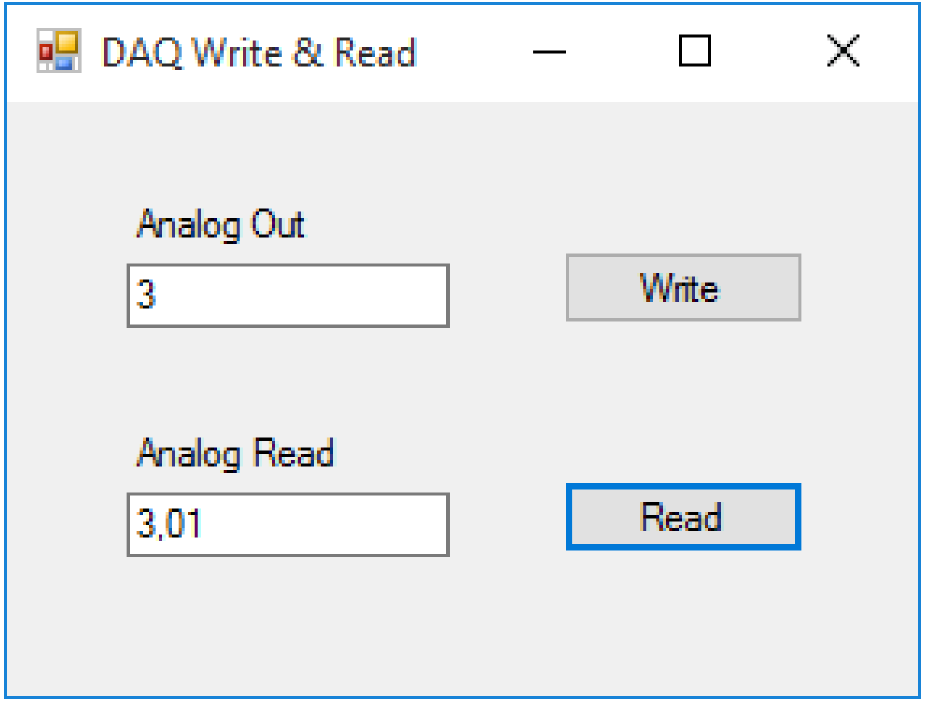
3



Analog Read:

3,01

Write/Read Data using USB-6008



Analog Out

3

Analog Read

3,01

Improvements

Hans-Petter Halvorsen, M.Sc.

Improvements

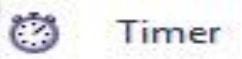
- Using a Timer
- Trend/Plot the Data from the DAQ device in a Chart
- Create and Use separate Classes for implementing the DAQ code
- …

Timer

In Visual Studio you may want to use a Timer instead of a While Loop in order to read values at specific intervals.

Example

1



Timer

Select the “Timer” component in the Toolbox

2

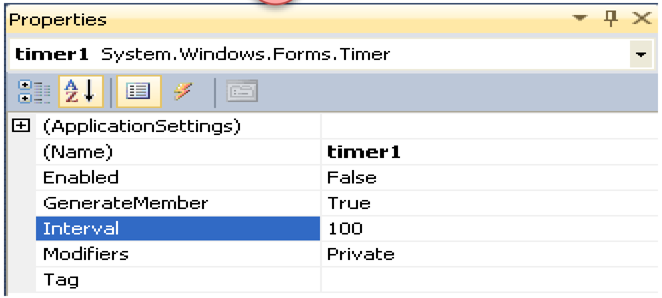
Initialization:

```
public Form1()
      {
          InitializeComponent();

          timer1.Start();
      }
```

Double-click on the Timer object in order to create the Event

Properties:

3



Properties

timer1 System.Windows.Forms.Timer

⊞ (ApplicationSettings)	
(Name)	**timer1**
Enabled	False
GenerateMember	True
Interval	100
Modifiers	Private
Tag	

You may specify the Timer Interval in the Properties Window

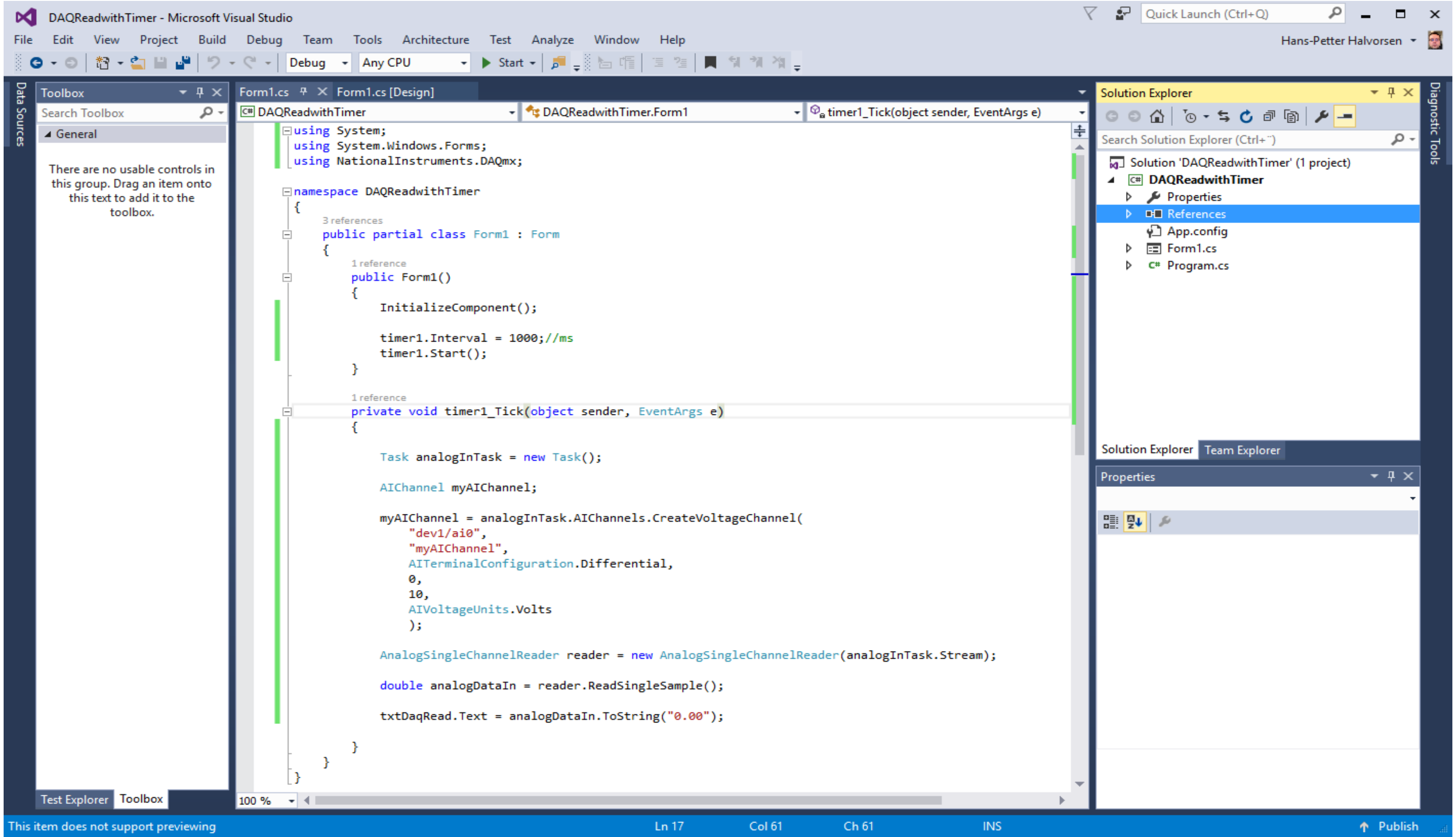
4

Timer Event:

```
private void timer1_Tick(object sender, EventArgs e)
      {
          … //Read from DAQ Device
          … //Formatting
          … //Plot Data
      }
```

Structure your Code properly!!
Define Classes and Methods which you can use here

Read DAQ Values using a Timer



There are no usable controls in this group. Drag an item onto this text to add it to the toolbox.

```
using System;
using System.Windows.Forms;
using NationalInstruments.DAQmx;

namespace DAQReadwithTimer
{
    3 references
    public partial class Form1 : Form
    {
        1 reference
        public Form1()
        {
            InitializeComponent();

            timer1.Interval = 1000;//ms
            timer1.Start();
        }

        1 reference
        private void timer1_Tick(object sender, EventArgs e)
        {

            Task analogInTask = new Task();

            AIChannel myAIChannel;

            myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
                "dev1/ai0",
                "myAIChannel",
                AITerminalConfiguration.Differential,
                0,
                10,
                AIVoltageUnits.Volts
                );

            AnalogSingleChannelReader reader = new AnalogSingleChannelReader(analogInTask.Stream);

            double analogDataIn = reader.ReadSingleSample();

            txtDaqRead.Text = analogDataIn.ToString("0.00");

        }
    }
}
```

This item does not support previewing

```
using System;
using System.Windows.Forms;
using NationalInstruments.DAQmx;

namespace DAQReadwithTimer
{
  public partial class Form1 : Form
  {
    public Form1()
    {
      InitializeComponent();

      timer1.Interval = 1000;//ms
      timer1.Start();
    }

    private void timer1_Tick(object sender, EventArgs e)
    {
      Task analogInTask = new Task();
      AIChannel myAIChannel;

      myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
        "dev1/ai0",
        "myAIChannel",
        AITerminalConfiguration.Differential,
        0,
        10,
        AIVoltageUnits.Volts
        );

      AnalogSingleChannelReader reader = new AnalogSingleChannelReader(analogInTask.Stream);

      double analogDataIn = reader.ReadSingleSample();

      txtDaqRead.Text = analogDataIn.ToString("0.00");

    }
  }
}
```

Trending Data in Visual Studio

Example

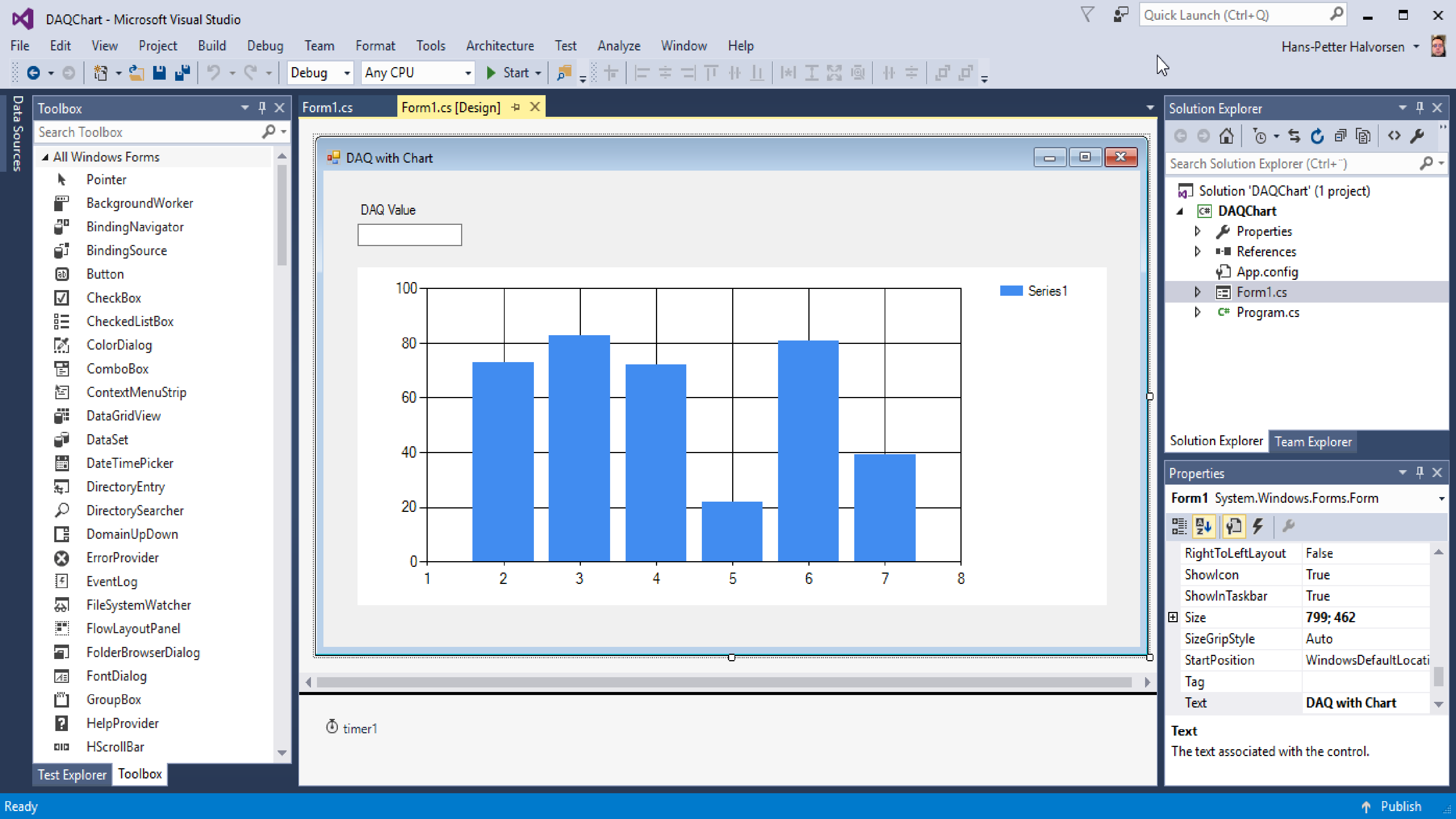
Visual Studio has a Chart control that you can use in Windows Forms or Web application (ASP.NET)

https://msdn.microsoft.com/en-us/library/dd489237.aspx

http://www.i-programmer.info/programming/uiux/2756-getting-started-with-net-charts.html

```
using System.Windows.Forms.DataVisualization.Charting;
...
chart1.Series.Clear();
chart1.Series.Add("My Data");
chart1.Series["My Data"].ChartType = SeriesChartType.Line;
...
int[] x = {1, 2, 3, 4, 5, 6, 7, 8};
int[] y = {20, 22, 25, 24, 28, 27, 24, 26};
for (int i = 0; i < x.Length; i++)
{
   chart1.Series["My Data"].Points.AddXY(x[i],y[i]);
}
```

Creating a Web App? Use the following Namespace instead:
System.Web.UI.DataVisualization.Charting

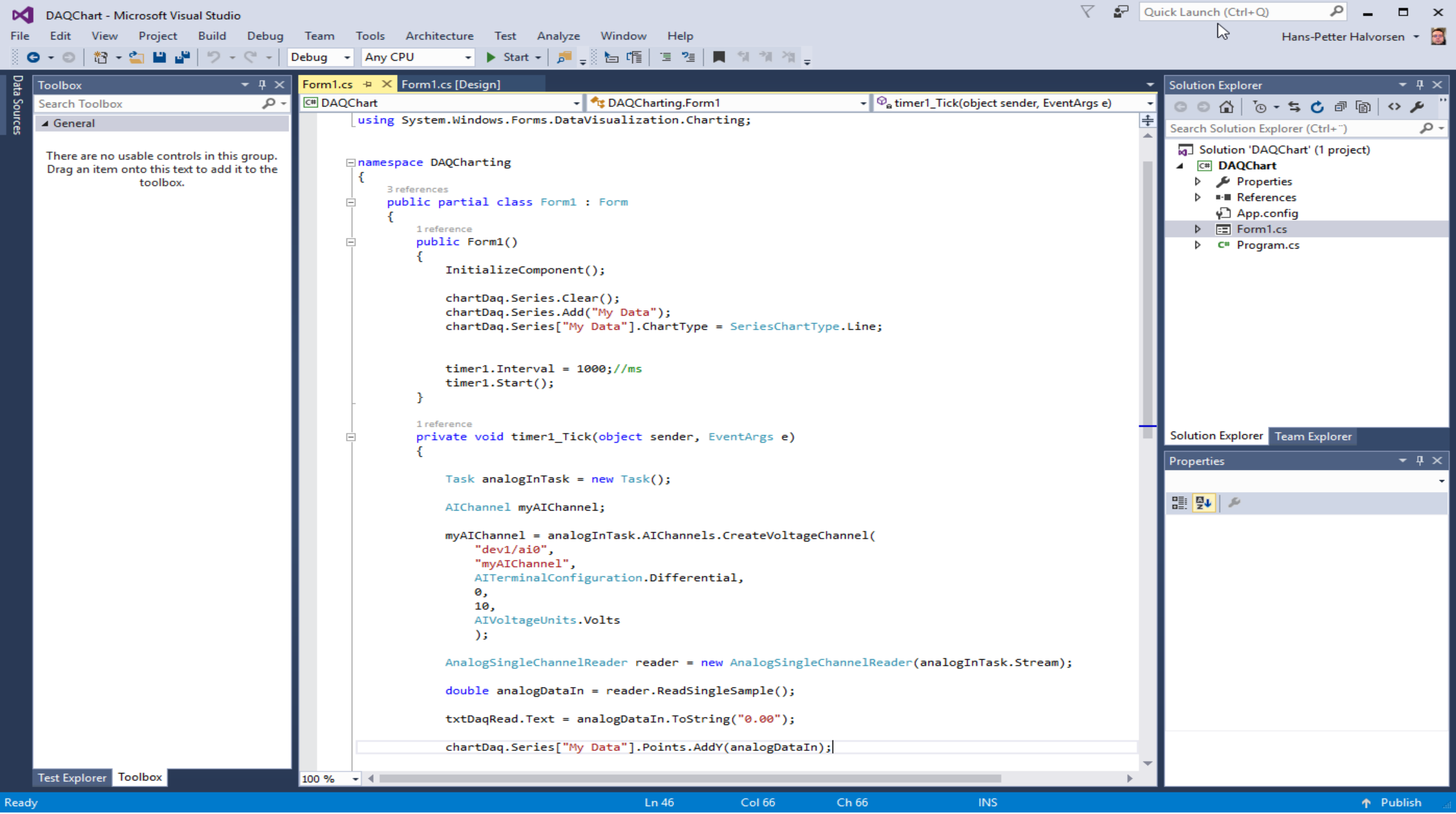


Form1 System.Windows.Forms.Form

RightToLeftLayout	False
ShowIcon	True
ShowInTaskbar	True
Size	799; 462
SizeGripStyle	Auto
StartPosition	WindowsDefaultLocati
Tag	
Text	DAQ with Chart

Text

The text associated with the control.



```
using System.Windows.Forms.DataVisualization.Charting;


namespace DAQCharting
{
    public partial class Form1 : Form
    {
        public Form1()
        {
            InitializeComponent();

            chartDaq.Series.Clear();
            chartDaq.Series.Add("My Data");
            chartDaq.Series["My Data"].ChartType = SeriesChartType.Line;


            timer1.Interval = 1000;//ms
            timer1.Start();
        }

        private void timer1_Tick(object sender, EventArgs e)
        {

            Task analogInTask = new Task();

            AIChannel myAIChannel;

            myAIChannel = analogInTask.AIChannels.CreateVoltageChannel(
                "dev1/ai0",
                "myAIChannel",
                AITerminalConfiguration.Differential,
                0,
                10,
                AIVoltageUnits.Volts
                );

            AnalogSingleChannelReader reader = new AnalogSingleChannelReader(analogInTask.Stream);

            double analogDataIn = reader.ReadSingleSample();

            txtDaqRead.Text = analogDataIn.ToString("0.00");

            chartDaq.Series["My Data"].Points.AddY(analogDataIn);
```

Hans-Petter Halvorsen

University of South-Eastern Norway

www.usn.no

E-mail: hans.p.halvorsen@usn.no

Web: https://www.halvorsen.blog