MCT 4334

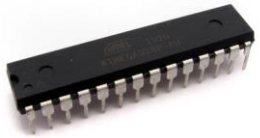
Embedded System Design

Week 14 Design Choices

Outline

- ASIC
- Microcontroller
- Single-board computer
- FPGA

Microcontroller vs Single board-computer



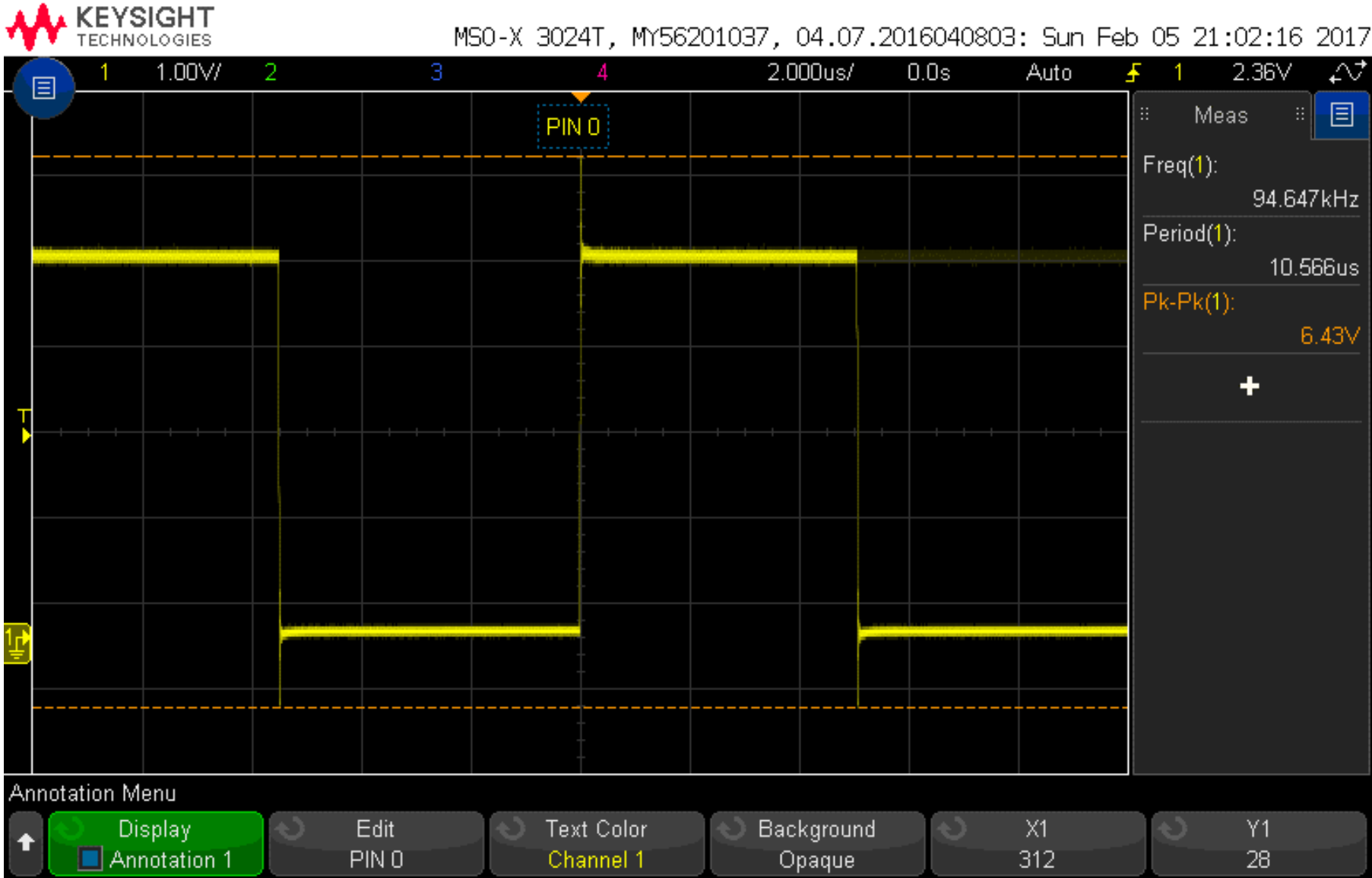
- Much slower than SBCs
- Much lower in power consumption than microcontrollers.
- Bare-metal programming.
- Usually used when low level of computation is required.

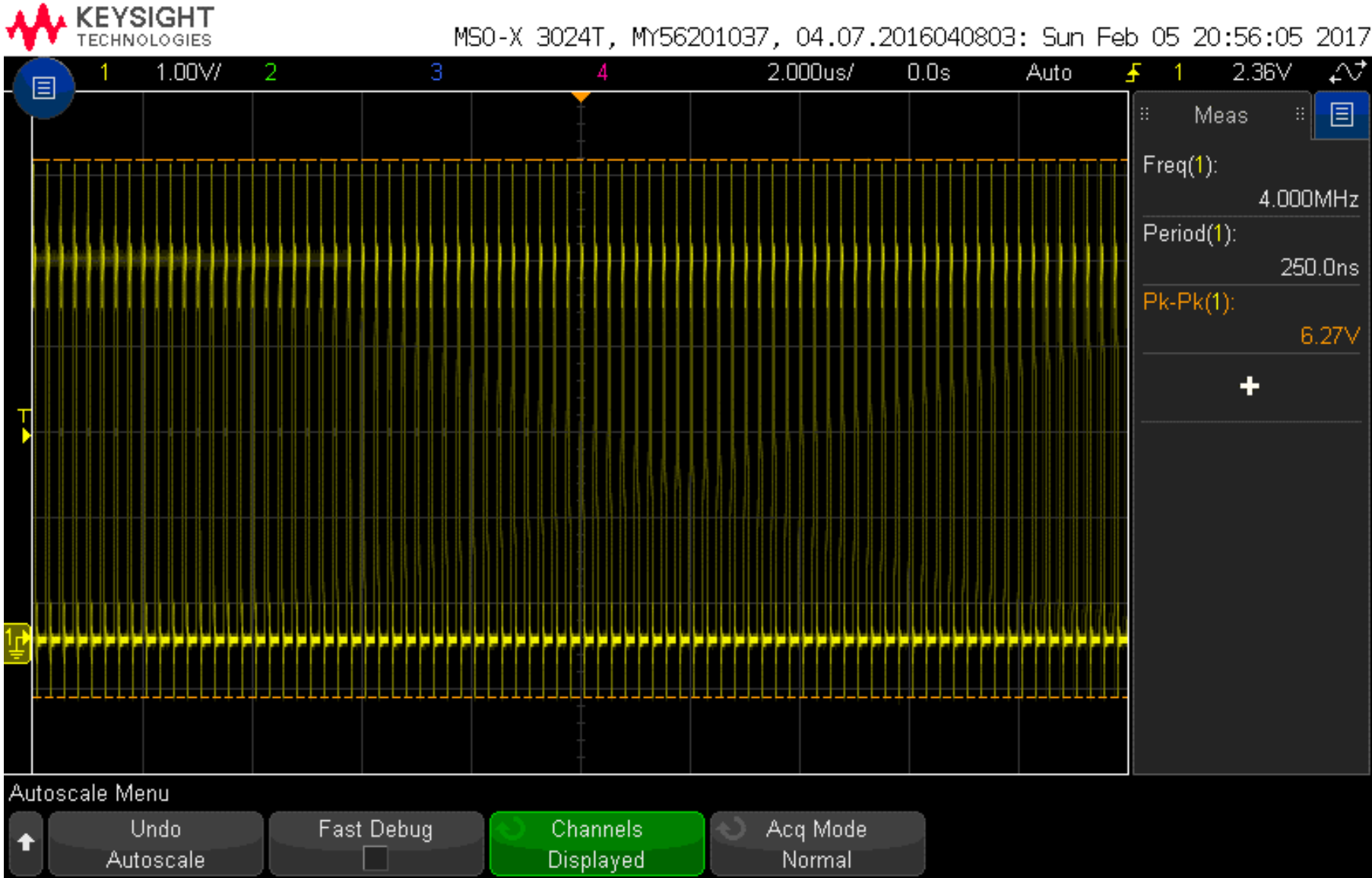
- A single-board computer (like Raspberry pi) is a fully-functional **computer** on one board.
- Much faster than microcontrollers.
- Much higher in power consumption than microcontrollers.
- An operating system can be installed and high level programming languages (such as python, C#, Java) can be utilized.
- Usually used when heavy computation is necessary.

```
void setup()
{

    pinMode(0, OUTPUT);

    for (;;)
    {
        digitalWrite(0, HIGH);
        digitalWrite(0, LOW);
    }
}

void loop()
{


}
```

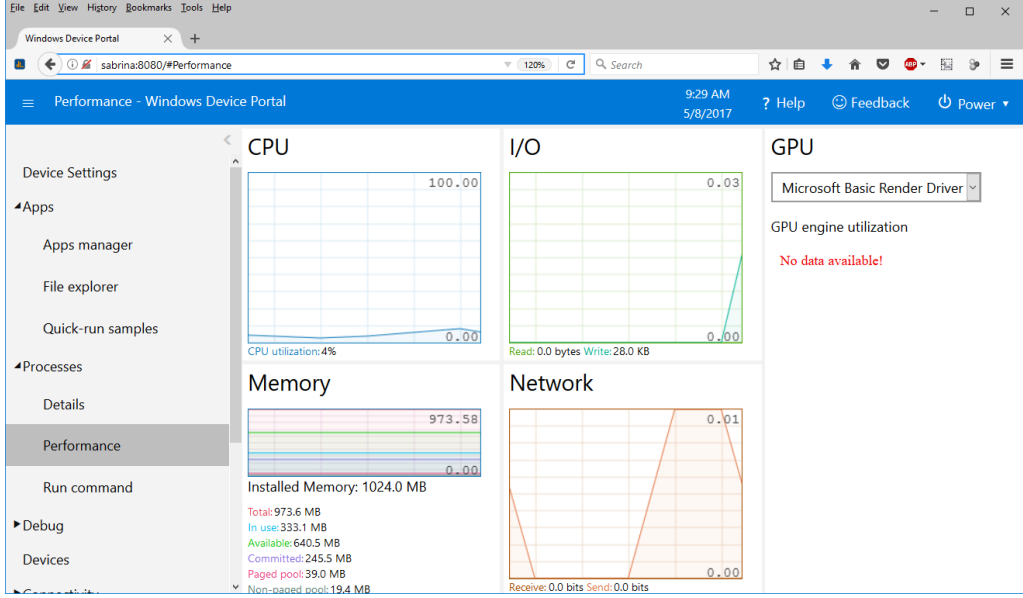
Frequency:

94.647 kHz



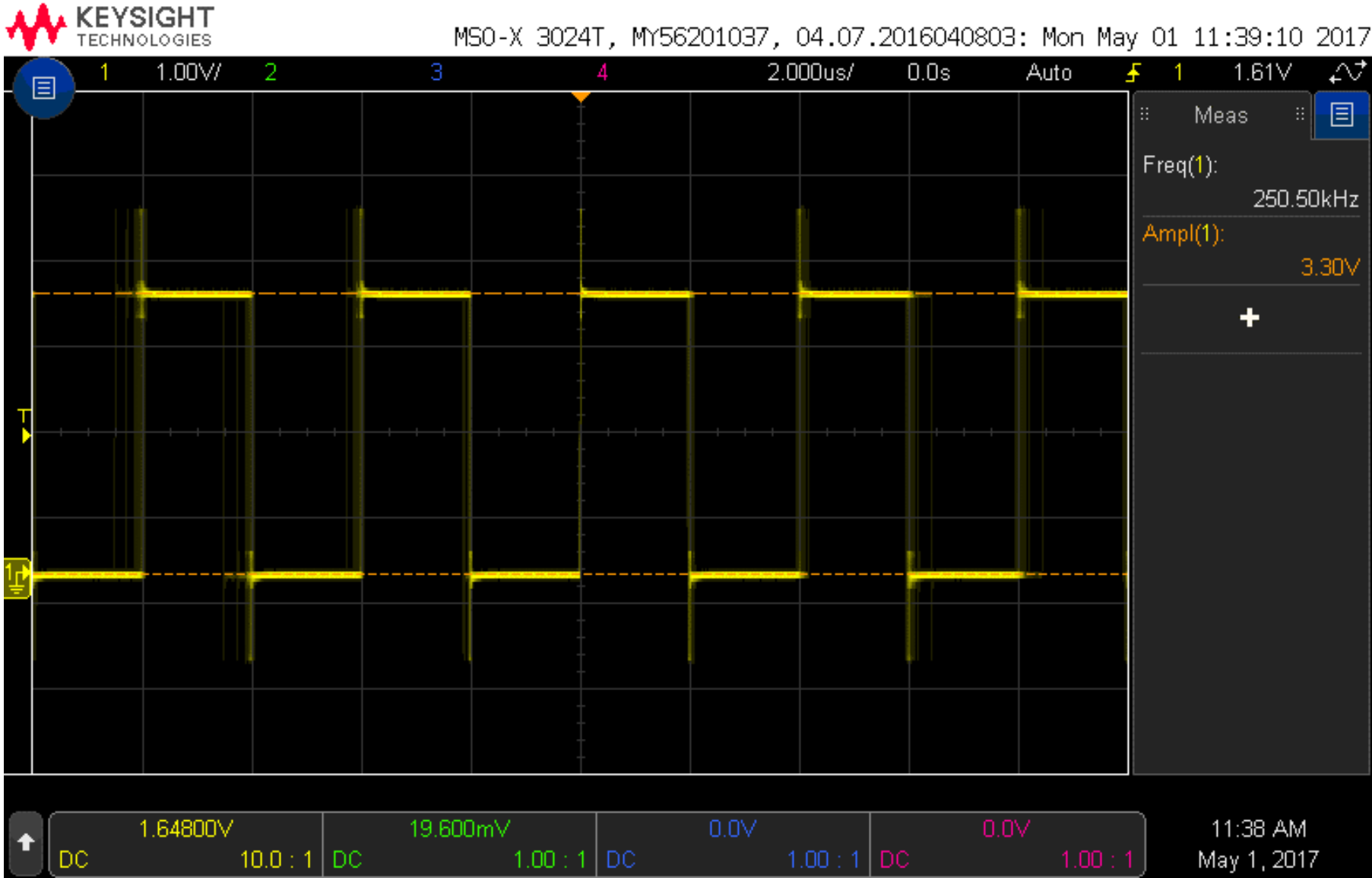

KEYSIGHT
TECHNOLOGIES
MSO-X 3024T, MY56201037, 04.07.2016040803: Sun Feb 05 20:56:05 2017
1 1.00V/ 2 3 4 2.000us/ 0.0s Auto 1 2.36V
Meas
Freq(1):
4.000MHz
Period(1):
250.0ns
Pk-Pk(1):
6.27V
Autoscale Menu
Undo Autoscale
Fast Debug
Channels Displayed
Acq Mode Normal

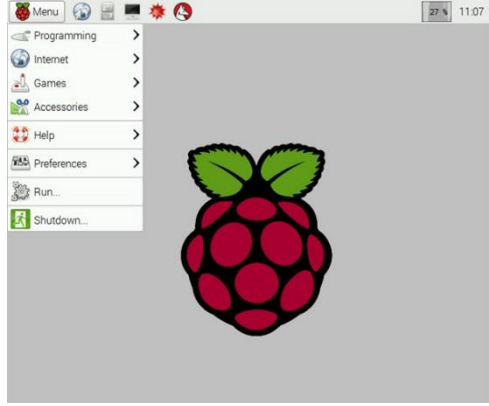
```
using Windows.ApplicationModel.Background;
using Windows.Devices.Gpio;

namespace GPIO_Benchmark
{
    public sealed class StartupTask : IBackgroundTask
    {
        public void Run(IBackgroundTaskInstance taskInstance)
        {
            GpioController gpio = GpioController.GetDefault();
            GpioPin pin = gpio.OpenPin(20);
            pin.SetDriveMode(GpioPinDriveMode.Output);

            for (;;)
            {
                pin.Write(GpioPinValue.High);
                pin.Write(GpioPinValue.Low);
            }
        }
    }
}
```



Web-interface of Windows 10 IOT Core

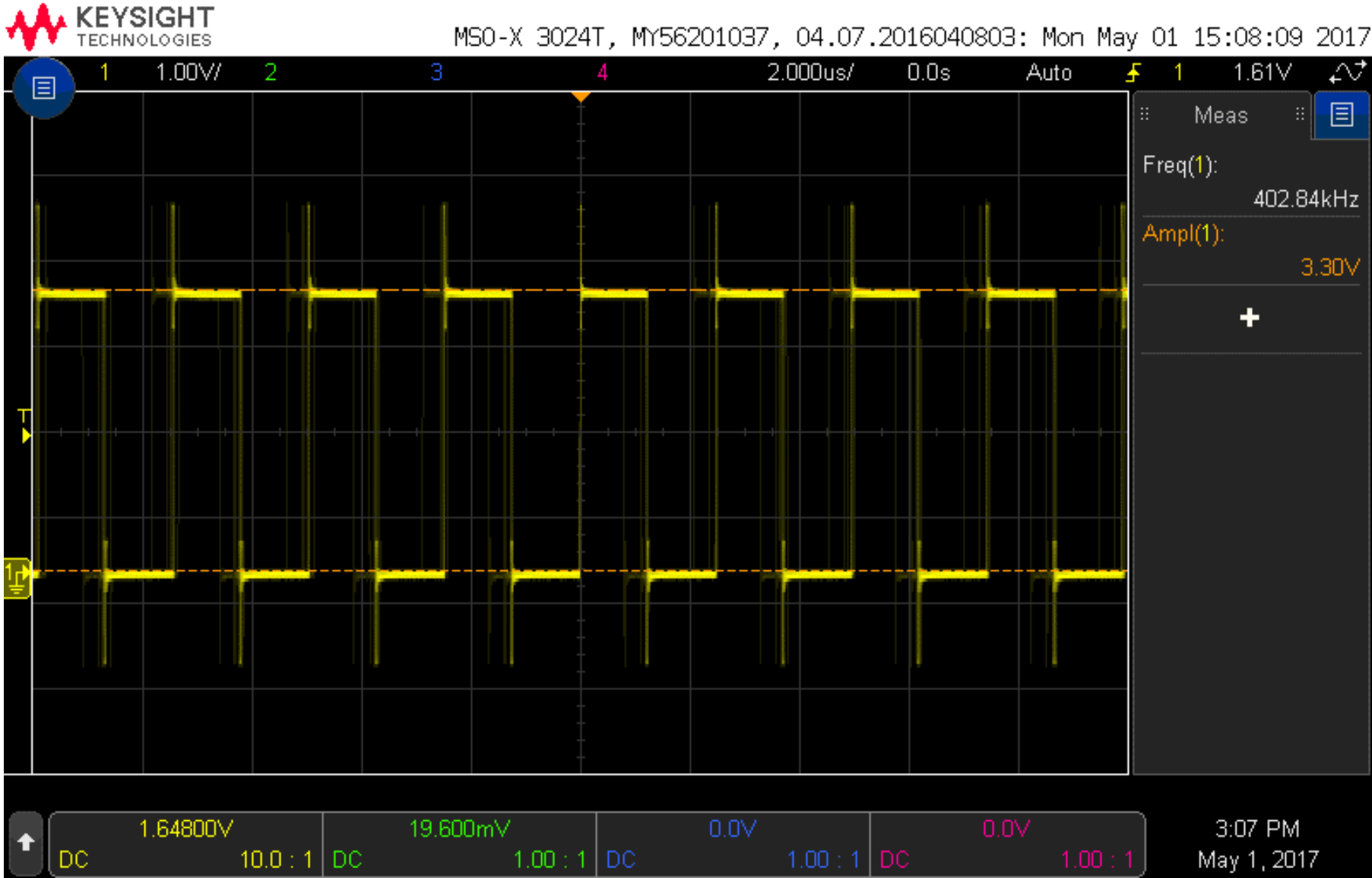
Board: Raspberry Pi 3
OS: Windows 10 IOT Core
Library: Windows IOT Extension for UWP
Language: C#


KEYSIGHT
TECHNOLOGIES
MSO-X 3024T, MY56201037, 04.07.2016040803: Mon May 01 11:39:10 2017
1 1.00V/ 2 3 4 2.000us/ 0.0s Auto 1 1.61V
Meas
Freq(1):
250.50kHz
Ampl(1):
3.30V
1.64800V
DC 10.0 : 1
19.600mV
DC 1.00 : 1
0.0V
DC 1.00 : 1
0.0V
DC 1.00 : 1
11:38 AM
May 1, 2017




```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)

GPIO.setup(20, GPIO.OUT)

while True:
    GPIO.output(20, True)
    GPIO.output(20, False)
```

Board: Raspberry Pi 3
OS: Raspbian Jessie
Library: Rpi GPIO
Language: Python


KEYSIGHT
TECHNOLOGIES
MSO-X 3024T, MY56201037, 04.07.2016040803: Mon May 01 15:08:09 2017
1 1.00V/ 2 3 4 2.000us/ 0.0s Auto 1 1.61V
Meas
Freq(1):
402.84kHz
Ampl(1):
3.30V
1.64800V
DC 10.0 : 1
19.600mV
DC 1.00 : 1
0.0V
DC 1.00 : 1
0.0V
DC 1.00 : 1
3:07 PM
May 1, 2017

Application specific integrated circuit (ASIC)

- ASIC is an IC designed for a specific purpose (instead of general-purpose)

For example

An intelligent controller for a traffic light

- Can be developed using a microncontroller (which is general-purpose)
- Can be developed using discrete electronic components such as transistors, diodes, transistor and capacitors (specific purpose) and then packaged into a single IC called ASIC.

ASIC vs Microcontroller

- Systems deployed as ASICs are faster than those on microcontrollers.
- Less power consumption.

- Longer development time
- Cannot modify and produce new versions.

- Systems running on microcontrollers are slower than those deployed as ASICs.
- More power consumption.

- Shorter development time
- Can be re-programmed. Easy to fix errors by producing new versions.

Field Programmable Gate Array (FPGA)

- Similar to ASICs.
- But FPGAs contain an array of programmable logic blocks, which can be programmed using hardware description language.
- Logic blocks can be configured to perform complex combinational and sequential logic.