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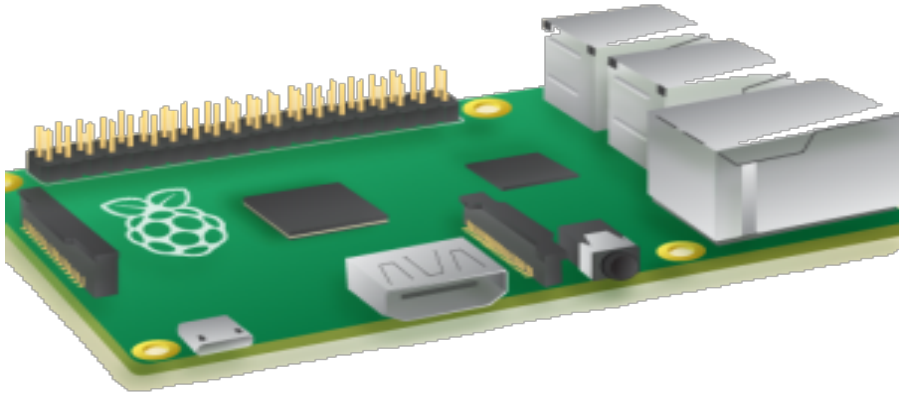
Raspberry Pi



Hans-Petter Halvorsen, M.Sc.

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Raspberry Pi 2

https://www.raspberrypi.org

https://dev.windows.com/iot

Hans-Petter Halvorsen, M.Sc.

Raspberry Pi 2 - Overview

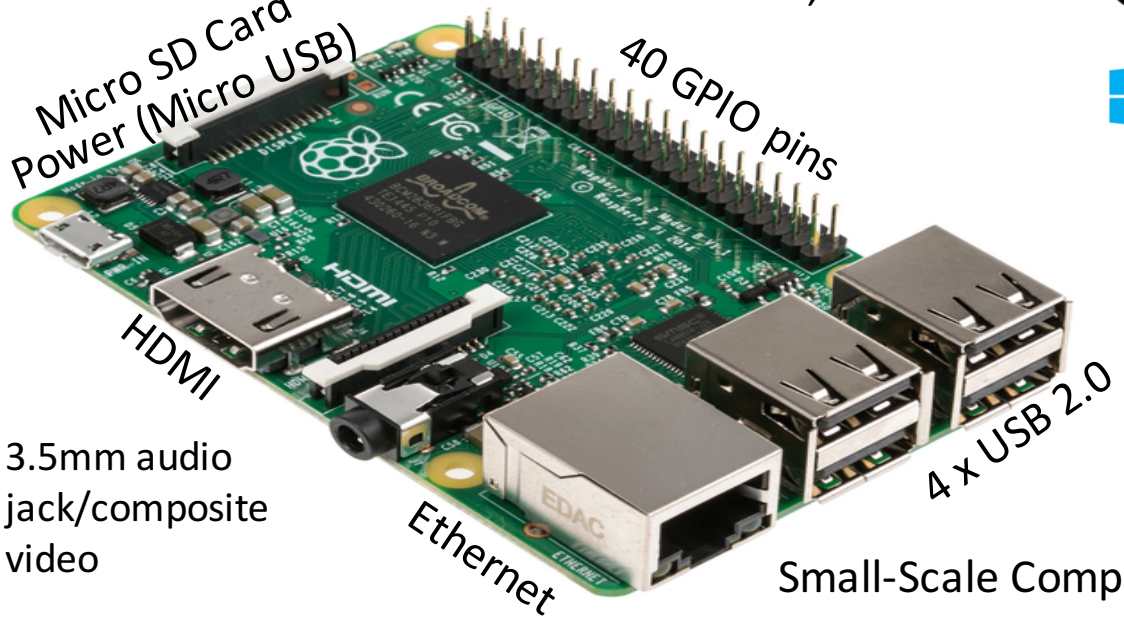
The Raspberry Pi 2 is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. The Raspberry Pi 2 can run Windows 10 IoT Core.

A 900MHz quad-core ARM Cortex-A7 CPU, 1GB RAM

Raspberry Pi

Windows 10

Windows 10 IoT Core



Small-Scale Computer

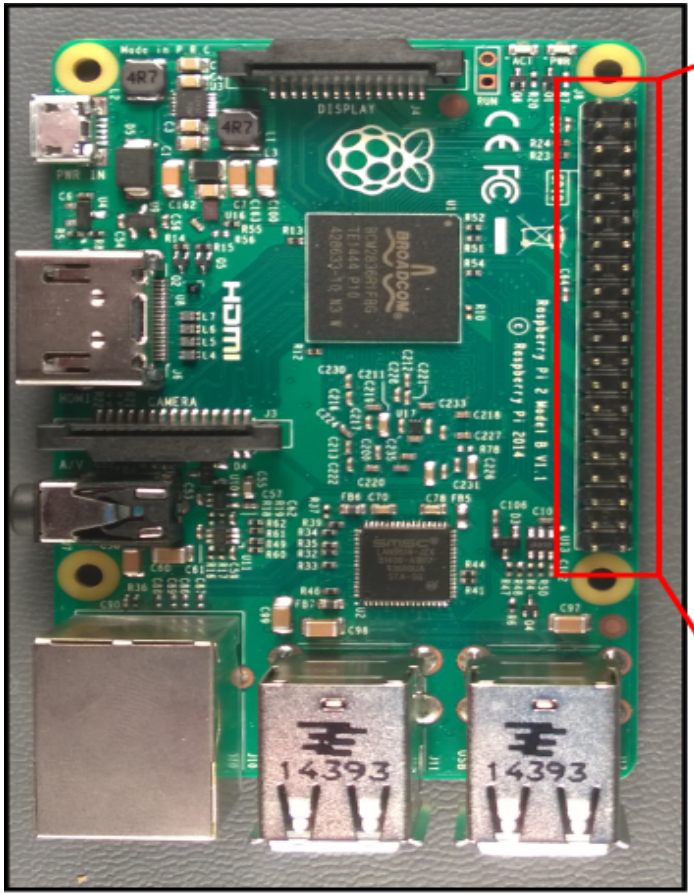
13x - GPIO pins
2x - SPI buses
1x - I2C bus
2x - 5V power pins
2x - 3.3V power pins
8x - Ground pins

Raspberry Pi 2 - Connectors

The Raspberry Pi 2 type B runs a quad-core ARM Cortex-A7 CPU and 1 GB RAM. It offers the following Connectors:

- 4 x USB 2.0 sockets
- 10/100 BaseT Ethernet socket
- HDMI video socket
- RCA composite video socket
- microSD card socket
- Powered from microUSB socket
- 3.5 mm audio out jack
- Header for GPIO and serial buses (I2C and SPI)
- Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane
- Camera connector 15-pin MIPI Camera Serial Interface (CSI-2)

Raspberry Pi 2 - Pin Mappings

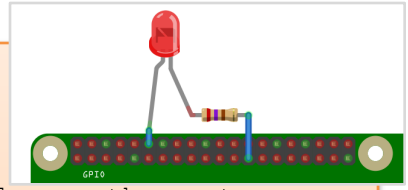


3.3V PWR	1		2	5V PWR
I2C1 SDA	3		4	5V PWR
I2C1 SCL	5		6	GND
GPIO 4	7		8	Reserved
GND	9		10	Reserved
SPI1 CS0	11		12	GPIO 18
GPIO 27	13		14	GND
GPIO 22	15		16	GPIO 23
3.3V PWR	17		18	GPIO 24
SPI0 MOSI	19		20	GND
SPI0 MISO	21		22	GPIO 25
SPI0 SCLK	23		24	SPI0 CS0
GND	25		26	SPI0 CS1
Reserved	27		28	Reserved
GPIO 5	29		30	GND
GPIO 6	31		32	GPIO 12
GPIO 13	33		34	GND
SPI1 MISO	35		36	GPIO 16
GPIO 26	37		38	SPI1 MOSI
GND	39		40	SPI1 SCLK

Raspberry Pi 2 – GPIO

GPIO: General Purpose Input/Output

These Pins can be used for Digital Input/Output



```
using Windows.Devices.Gpio;

public void GPIO()
{
    // Get the default GPIO controller on the system
    GpioController gpio = GpioController.GetDefault();
    if (gpio == null)
        return; // GPIO not available on this sytem

    // Open GPIO 5
    using (GpioPin pin = gpio.OpenPin(5))
    {
        // Latch HIGH value
        pin.Write(GpioPinValue.High);

        // Set the IO direction as output
        pin.SetDriveMode(GpioPinDriveMode.Output);

    } // Close pin - will revert to its power-on state
}
```

This Example opens **GPIO 5** as an output and writes a digital **'1'** out on the pin

GPIO#	Power-on Pull	Header Pin
4	PullUp	7
5	PullUp	29
6	PullUp	31
12	PullDown	32
13	PullDown	33
16	PullDown	36
18	PullDown	12
22	PullDown	15
23	PullDown	16
24	PullDown	18
25	PullDown	22
26	PullDown	37
27	PullDown	13
35	PullUp	Red Power LED
47	PullUp	Green Activity LED

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Raspberry Pi

Windows 10 IoT Core for Raspberry Pi 2

Hans-Petter Halvorsen, M.Sc.

Windows 10 IoT Core

- Windows 10 IoT Core is a small scaled version of Windows running on small devices such as Raspberry Pi 2
- https://dev.windows.com/iot

IoT – Internet of Things

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Raspberry Pi

Communication Protocols

Hans-Petter Halvorsen, M.Sc.

Communication Protocols

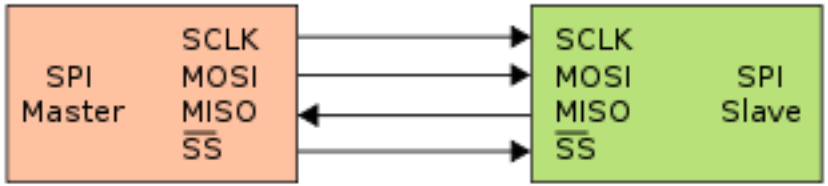
- UART (Universal Asynchronous Receiver/Transmitter,)
- …
  - http://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter
- SPI (Serial Peripheral Interface)
  - …
  - http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus
- I2C (Inter-Integrated Circuit)
  - …
  - http://en.wikipedia.org/wiki/I2C

http://www.byteparadigm.com/applications/introduction-to-i2c-and-spi-protocols

Raspberry Pi 2 – SPI Bus

- Serial Peripheral Interface (SPI) is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances.
- With an SPI connection there is always one master device (usually a microcontroller) which controls the peripheral devices.
- SPI devices communicate in full duplex mode using a master-slave architecture with a single master.
- The interface was developed by Motorola and has become a de facto standard.
- Typical applications include sensors, Secure Digital cards, and liquid crystal displays (LCD).

SCLK : Serial Clock (output from master)
MOSI : Master Output, Slave Input (output from master)
MISO : Master Input, Slave Output (output from slave)
SS (or SC) : Slave Select (active low, output from master)



http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

https://learn.sparkfun.com/tutorials/serial-peripheral-interface-spi

Raspberry Pi 2 – SPI Bus

There are 2 SPI bus controllers available on the RPi2: **SPI0** and **SPI1**

SPI0:
Pin 19 - SPI0 MOSI
Pin 21 - SPI0 MISO
Pin 23 - SPI0 SCLK
Pin 24 - SPI0 CS0
Pin 26 - SPI0 CS1

SPI1:
Pin 38 - SPI1 MOSI
Pin 35 - SPI1 MISO
Pin 40 - SPI1 SCLK
Pin 11 - SPI1 CS0

```
using Windows.Devices.Enumeration;
using Windows.Devices.Spi;

public async void SPI()
{
    // Get a selector string for bus "SPI0"
    string aqs = SpiDevice.GetDeviceSelector("SPI0");

    // Find the SPI bus controller device with our selector string
    var dis = await DeviceInformation.FindAllAsync(aqs);
    if (dis.Count == 0);
        return; // "SPI0" not found on this system

    // Use chip select line CS0
    var settings = new SpiConnectionSettings(0);

    // Create an SpiDevice with our bus controller and SPI settings
    using (SpiDevice device = await SpiDevice.FromIdAsync(dis[0].Id, settings))
    {
        byte[] writeBuf = { 0x01, 0x02, 0x03, 0x04 };
        device.Write(writeBuf);
    }
}
```

Raspberry Pi 2 - I2C Bus

- I^2C (Inter-Integrated Circuit), is a multi-master, multi-slave, single-ended, serial computer bus
- It is typically used for attaching lower-speed peripheral ICs to processors and microcontrollers.
- I^2C is typically spelled I2C (pronounced I-two-C)
- The I^2C bus was developed in 1982 by Philips Semiconductor.
- The I^2C protocol requires only 2 wires for connecting all the peripheral to a microcontroller.

http://en.wikipedia.org/wiki/I2C

https://learn.sparkfun.com/tutorials/i2c

Raspberry Pi 2 - I2C Bus

There is one I2C controller **I2C1** exposed on the pin header with two lines **SDA** and **SCL**. 1.8KΩ internal pull-up resistors are already installed on the board for this bus.

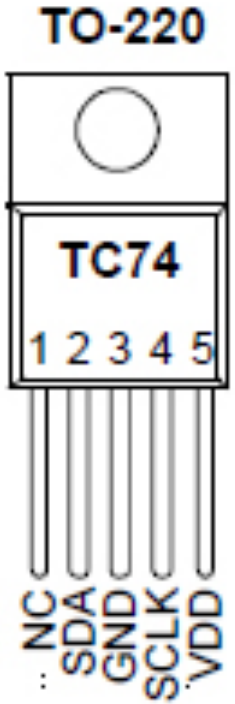
Pin 3 - I2C1 SDA
Pin 5 - I2C1 SCL

SDA: Serial Data Line

SCL: Serial Clock Line

```
using Windows.Devices.Enumeration;
using Windows.Devices.I2c;

public async void I2C()
{
    // Get a selector string for bus "I2C1"
    string aqs = I2cDevice.GetDeviceSelector("I2C1");

    // Find the I2C bus controller with our selector string
    var dis = await DeviceInformation.FindAllAsync(aqs);
    if (dis.Count == 0)
        return; // bus not found

    // 0x40 is the I2C device address
    var settings = new I2cConnectionSettings(0x40);

    // Create an I2cDevice with our selected bus controller and I2C settings
    using (I2cDevice device = await I2cDevice.FromIdAsync(dis[0].Id, settings))
    {
        byte[] writeBuf = { 0x01, 0x02, 0x03, 0x04 };
        device.Write(writeBuf);
    }
}
```

Digital Temperature Sensor with I²C Interface

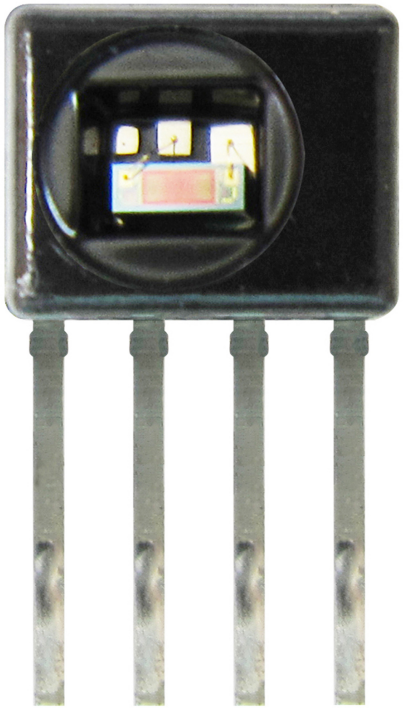


http://home.hit.no/~hansha/documents/lab/Lab%20Equipment/iot_sensors.htm

Honeywell Humidity Sensor

with I^2C /SPI Interface

Honeywell HIH-6120-021-001 4-Pin SIP Temperature & Humidity Sensor



http://home.hit.no/~hansha/documents/lab/Lab%20Equipment/iot_sensors.htm

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Raspberry Pi

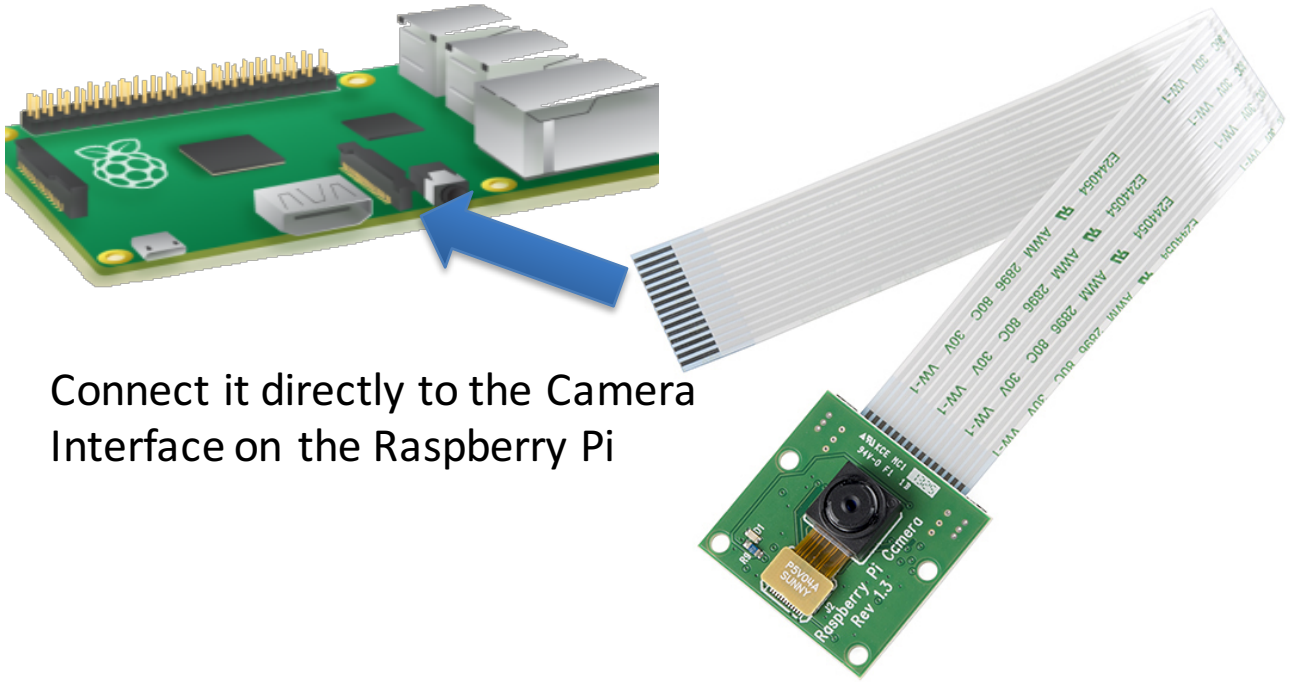
Raspberry Pi Camera

Hans-Petter Halvorsen, M.Sc.

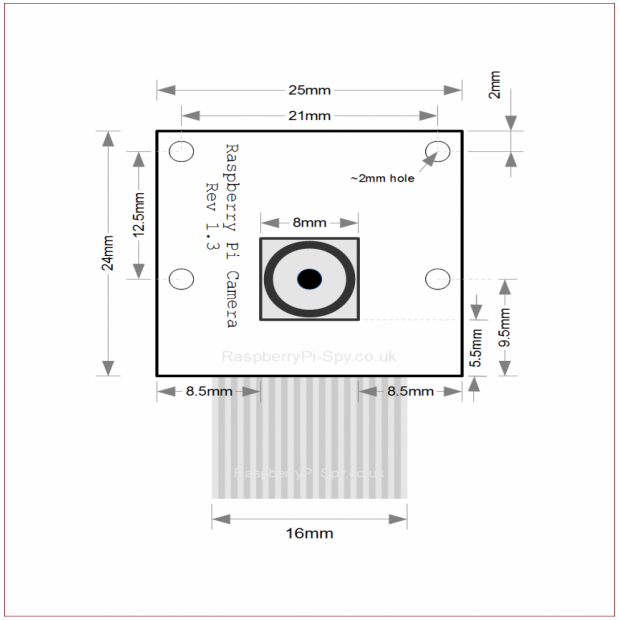
Raspberry Pi Camera

The Raspberry Pi Camera is ideal for Home Security Applications

https://www.raspberrypi.org/help/camera-module-setup/



Connect it directly to the Camera Interface on the Raspberry Pi



5 megapixel resolution
Still images 2592 x 1944
Video: 1080p30

Note! This module is only capable of taking pictures and video, not sound

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