

# Electronics Block Diagrams

Terry Sturtevant

Wilfrid Laurier University

February 13, 2019

# Introduction

# Introduction

- There are many different ways to describe a circuit or a system.

# Introduction

- There are many different ways to describe a circuit or a system.
- One way to describe a circuit is with a **schematic diagram**.

# Introduction

- There are many different ways to describe a circuit or a system.
- One way to describe a circuit is with a **schematic diagram**.  
For a large or complex circuit, a schematic diagram may be difficult to understand.

# Introduction

- There are many different ways to describe a circuit or a system.
- One way to describe a circuit is with a **schematic diagram**.  
For a large or complex circuit, a schematic diagram may be difficult to understand.
- A **block diagram** allows a circuit or system to be described as a set of **modules**.

# Introduction

- There are many different ways to describe a circuit or a system.
- One way to describe a circuit is with a **schematic diagram**.  
For a large or complex circuit, a schematic diagram may be difficult to understand.
- A **block diagram** allows a circuit or system to be described as a set of **modules**.  
By identifying the modules, and showing how they are connected, it provides a simple overview.

# Introduction

- There are many different ways to describe a circuit or a system.
- One way to describe a circuit is with a **schematic diagram**.  
For a large or complex circuit, a schematic diagram may be difficult to understand.
- A **block diagram** allows a circuit or system to be described as a set of **modules**.  
By identifying the modules, and showing how they are connected, it provides a simple overview.
- Each module can then be described individually, and its function more easily understood.



# Simple Example

## Simple Example

A heating system, such as for a house, requires 3 parts:

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment
- A *heater*

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment
- A *heater*  
which *changes* the temperature of the environment

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment
- A *heater*  
which *changes* the temperature of the environment
- A *controller*

## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment
- A *heater*  
which *changes* the temperature of the environment
- A *controller*  
which uses information from the sensor to *adjust* the heater.



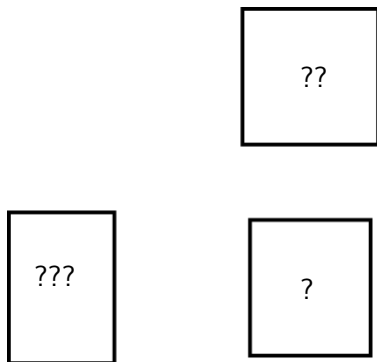
## Simple Example

A heating system, such as for a house, requires 3 parts:

- A temperature *sensor*  
which *measures* the temperature of the environment
- A *heater*  
which *changes* the temperature of the environment
- A *controller*  
which uses information from the sensor to *adjust* the heater.

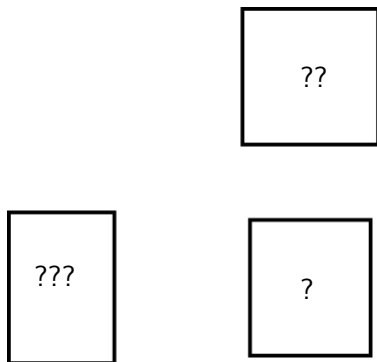
A diagram is simple to make.

## Block diagram



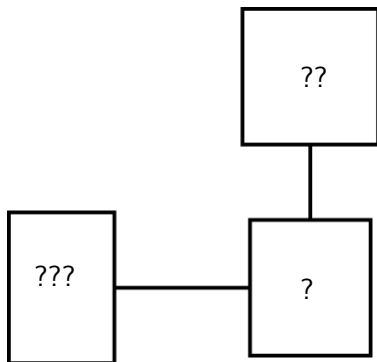
Heating System Block Diagram

## Block diagram



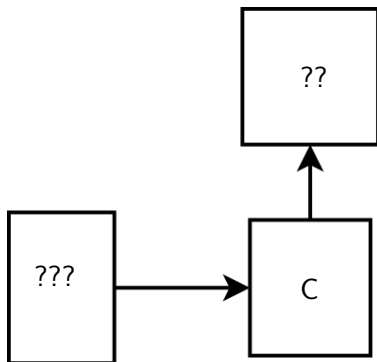
Can you tell which part is which?

## Block diagram



Now can you tell which part is which?

## Block diagram



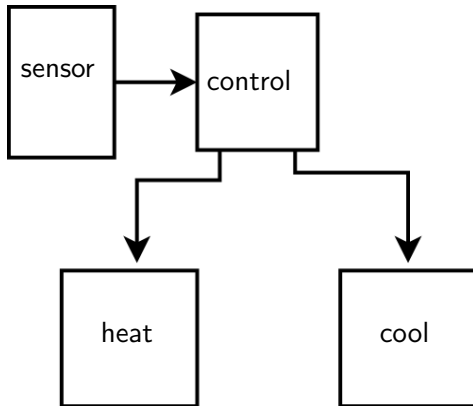
Now can you tell which part is which?

- By indicating signal *directions*, it makes the flow of control obvious

- By indicating signal *directions*, it makes the flow of control obvious

The diagram can be easily adapted to more complex systems.

## Slightly more complex example



Heating and Cooling System Block Diagram

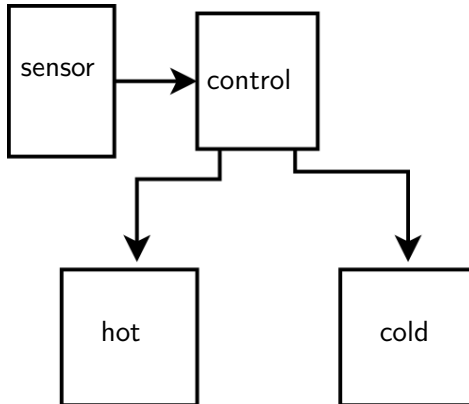


- The same block diagram could be used for a similar system in a different context

- The same block diagram could be used for a similar system in a different context
- For instance, this system could be used for controlling the water temperature in a shower

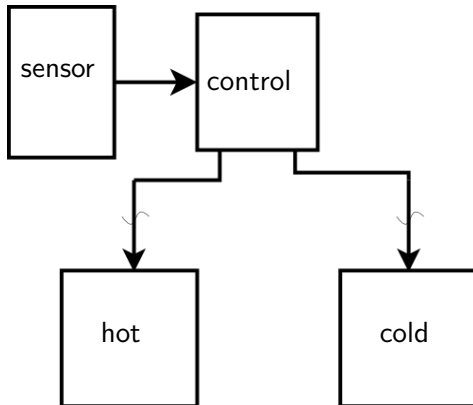
- The same block diagram could be used for a similar system in a different context
- For instance, this system could be used for controlling the water temperature in a shower
- To do this, replace heater and A/C with valves on the hot and cold lines

## Adapted example: shower control



Is there anything that needs to change?

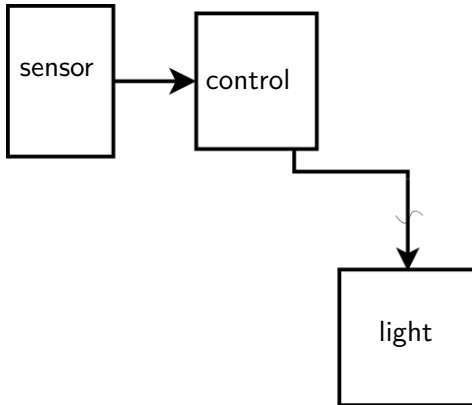
## Adapted example: shower control



Indicating the **type** of signal conveys important information.

- The original block diagram could also be used for a light control system

## Light control system



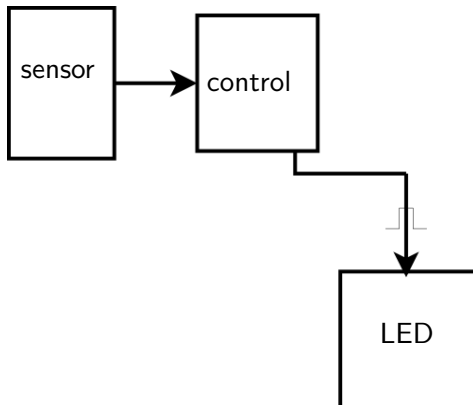
### Incandescent Light Control

- This will work for *incandescent* lights



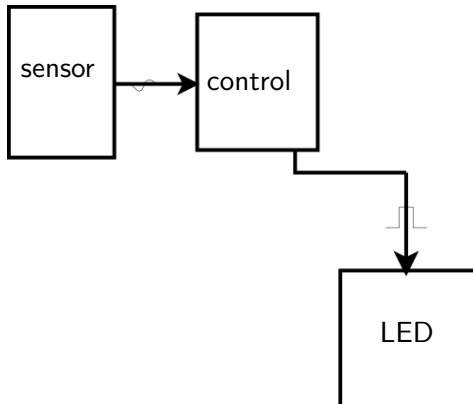
- This will work for *incandescent* lights  
What need to change for LED lights?

## LED light control system



LED Light Control; not quite done

## LED light control system



Complete LED Light Control

So the previous block diagram describes a system with:

So the previous block diagram describes a system with:

- A temperature *sensor*

So the previous block diagram describes a system with:

- A temperature *sensor*  
which produces an *analog signal* to indicate the light level

So the previous block diagram describes a system with:

- A temperature *sensor*  
    which produces an *analog signal* to indicate the light level
- An *LED light*

So the previous block diagram describes a system with:

- A temperature *sensor*  
which produces an *analog signal* to indicate the light level
- An *LED light*  
which *changes* the light level



So the previous block diagram describes a system with:

- A temperature *sensor*  
which produces an *analog signal* to indicate the light level
- An *LED light*  
which *changes* the light level
- A *controller*

So the previous block diagram describes a system with:

- A temperature *sensor*  
which produces an *analog signal* to indicate the light level
- An *LED light*  
which *changes* the light level
- A *controller*  
which takes in the *analog* signal from the sensor and produces a *pulse-width modulated* signal to the LED light.

So the previous block diagram describes a system with:

- A temperature *sensor*  
which produces an *analog signal* to indicate the light level
- An *LED light*  
which *changes* the light level
- A *controller*  
which takes in the *analog* signal from the sensor and produces a *pulse-width modulated* signal to the LED light.

**All of this can be determined without any other documentation.**

# Multiple signals and interfaces

## Multiple signals and interfaces

There may be more than one signal between two devices

## Multiple signals and interfaces

There may be more than one signal between two devices

- There could be several *independent signals of the same type*

## Multiple signals and interfaces

There may be more than one signal between two devices

- There could be several *independent signals of the same type*
- There could be an **interface** made up of several *dependent signals* with a **communication protocol**

## Multiple signals and interfaces

There may be more than one signal between two devices

- There could be several *independent signals of the same type*
- There could be an **interface** made up of several *dependent signals* with a **communication protocol**

(Interfaces usually include signals in both directions)



## Multiple signals and interfaces

There may be more than one signal between two devices

- There could be several *independent signals of the same type*
- There could be an **interface** made up of several *dependent signals* with a **communication protocol**

(Interfaces usually include signals in both directions)

It is easy and useful to have symbols for these as well.

# What's the difference between multiple signals and an interface?

## What's the difference between multiple signals and an interface?

- If there is a *library* to simplify the communication then it is an interface.

## What's the difference between multiple signals and an interface?

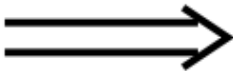
- If there is a *library* to simplify the communication then it is an interface.
- If there is no *library* then you have to handle all of the signals yourself.

## What's the difference between multiple signals and an interface?

- If there is a *library* to simplify the communication then it is an interface.
- If there is no *library* then you have to handle all of the signals yourself.

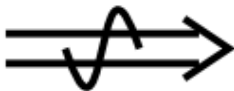
This process of handling all of the signals yourself is often called **bit-bashing** or **bit-banging**.

## Multiple signals



Multiple digital signals

## Multiple signals



Multiple analog signals

## Multiple signals



Multiple pulse-width modulated signals

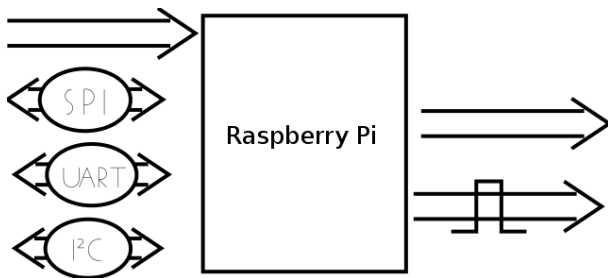


## Multiple signals



UART interface

# Evaluation



What can you tell about the Raspberry Pi?