

Digital Signals

Control systems and Computer Networks

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Lecture 1.3

Digital Signals

What is a digital signal?

A Digital Signal is:

Digital Signals

What is a digital signal?

A Digital Signal is:

True

Digital Signals

What is a digital signal?

A Digital Signal is:

True False

Digital Signals

What is a digital signal?

A Digital Signal is:

True	False
1	

Digital Signals

What is a digital signal?

A Digital Signal is:

True	False
1	0

Digital Signals

What is a digital signal?

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True	False
1	0
on	

Digital Signals

What is a digital signal?

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Digital Signals

What is a digital signal?

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True	False
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on	off
Pressed	

Digital Signals

What is a digital signal?

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Pressed	Not-pressed

Digital Signals

What is a digital signal?

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Pressed

Not-pressed

High

Digital Signals

What is a digital signal?

A Digital Signal is:

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High	Low

Digital Signals

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High	Low
5 V	

Digital Signals

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3.3 V

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- ▶ from a software perspective anything convenient for us to use

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 - Physics

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- ▶ there are external limitations and constraints,
 - Physics
 - Standards

Electrical Characteristics

Generally :

positive voltage logical 1

negative voltage logical 0

Electrical Characteristics

Generally :

positive voltage logical 1

negative voltage logical 0

Specific technologies have specific voltages for *on*

TTL Transistor Transistor Logic 5V

CMOS Complementary Metal Oxide Semiconductor 3.3V

Sequences

Digital signals exist in sequences...

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- ▶ Traffic Lights

Sequences

Digital signals exist in sequences...

- ▶ Traffic Lights

- Red \rightarrow Red,Amber \rightarrow Green \rightarrow Amber \rightarrow Red ...

Sequences

Digital signals exist in sequences...

- ▶ Traffic Lights

- Red \rightarrow Red,Amber \rightarrow Green \rightarrow Amber \rightarrow Red ...

- ▶ Flashing

Sequences

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- On \rightarrow Off \rightarrow On ...

Sequences

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Sequences

Digital signals exist in sequences...

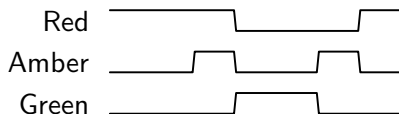
- ▶ Traffic Lights

- Red \rightarrow Red,Amber \rightarrow Green \rightarrow Amber \rightarrow Red ...

- ▶ Flashing

- On \rightarrow Off \rightarrow On ...

Can be written as a **Timing Diagram**



Digital IO from the μ C

Microcontrollers (μ C) have dedicated hardware for digital IO.

- ▶ The K64F has 5 ports with 32 IO pins which can be used as GPIO pins (General Purpose Input Output)
- ▶ The IO circuit has a number of configurable options for each pin, accessed through several registers
- ▶ **ALL** the appropriate bits need to be set or it doesn't work.

GPIO Hardware Registers

Sequence and purpose of bits to set

There are several bits to set to configure the pin

1. System Clock Gating Control Register **SCGC**

Enables the clock signal for the port, making it function

2. Pin Control Register **PORTx_PCRn**

a 32bit register for each pin setting several options

- IRQC – Interrupt configuration (what causes an interrupt to occur)
- MUX – Pins have multiple functions, this selects the function to use.
- DSE – Drive Strength, the electrical characteristics of the output
- ODE – Open Drain, electrical connections of the Output
- PFE – Passive Filter for inputs (debounce and glitch rejection)
- SLE – Slew Rate, how fast the output switches between high and Low
- PE – enable pull up or down resistor for inputs
- PS – selects the pull-up or pull-down resistor.

GPIO Hardware Registers

Port Registers

Each Port has several registers to use for the actual IO operations. Each bit in the register corresponds to an external pin.

GPIOx_PDOR Port Data Output Register

- 0. Set the output to logic 0
- 1. Set the output to logic 1

GPIOx_PSOR Port Set Output Register

- 0. output does not change
- 1. Set the output to logic 1

GPIOx_PCOR Port Clear Output Register

- 0. output does not change
- 1. Set the output to logic 0

GPIOx_PTOR Port Toggle Output Register

- 0. Output does not change
- 1. Change the logic state of the output

GPIO Hardware Registers

Port Registers

GPIOx_PDIR Port Data Input Register

- 0. Pin is set to input logic 0 (or is not configured)
- 1. Pin is set to input logic 1

GPIOx_PDDR Port Data Direction Register

- 0. GPIO pin set as input
- 1. GPIO pin set as output

IO Circuits

Output

- ▶ The μC pin is set to 0 or 1
- ▶ in the case of the K64F $1 \equiv 3.3\text{ V}$
- ▶ But what does that do?
- ▶ It depends on the external circuit.

The LED

