## Goals of the

# 4-Bit-Relay-Adder 

# How does a Relay-CPU calculate? 

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## Übersicht

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Half/Full
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## Goals

## Goals of the

project

- Preproject for EuroTwo
- Explainable binary calculation
- Design aspects
- (indirect) LED indicators for everything and illumination in general
- boardcolor
- haptics, feeling

Goals of the project

- Mechanical aspects
- Electronical aspects
- logic family


## vspace.one <br> Inspiration

Goals of the project

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Source: https://www.youtube.com/watch?v=x3pyi9P4N08

## Mein Ergebnis

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Relays

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Input 1


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Input 1


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## Binary

## Goals of the

- Working with 0,1
- Logic gates
- AND, OR, XOR, NOT, NOR, NAND
- Combining to building blocks
- Half/Full Adder, Registers, Counters, Multiplexer, Decoder, ...


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| OR |  |  |
| :---: | :---: | :---: |
| A | B | Output |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |



NAND

| A | B | Output |
| :---: | :---: | :---: |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |



NOR

| A | B | Output |
| :---: | :---: | :---: |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |



XOR

| A | B | Output |
| :---: | :---: | :---: |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |



XNOR

| A | B | Output |
| :---: | :---: | :---: |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

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## Relay logic

## Goals of the

| 0 | 1 |
| :---: | :---: |
| floating | +5 V |
| GND | +5 V |

## Facts

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## AND Gate

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## AND Gate

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## AND Gate

vspace, one

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## AND Gate

vspace,one

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## XOR Gate

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## XOR Gate

vspaceione

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## XOR Gate

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## XOR Gate

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## OR Gate

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Input 1 Input 2
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## Full Adder

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Adder



| A | B | C | Carry | Sum | CarrySum |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 0 | 0 | 0 | 0 | 00 |
| 0 | 0 | 1 | 0 | 1 | 01 |
| 0 | 1 | 0 | 0 | 1 | 01 |
| 0 | 1 | 1 | 1 | 0 | 10 |
| 1 | 0 | 0 | 0 | 1 | 01 |
| 1 | 0 | 1 | 1 | 0 | 10 |
| 1 | 1 | 0 | 1 | 0 | 10 |
| 1 | 1 | 1 | 1 | 1 | 11 |

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## 4 Bit Adder

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## Unsigned integers

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## Two's complement

## Goals of the <br> works <br> Logic <br> Relay logic

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## Two's complement

## Goals of the

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## Goals of the

| 0010 | 2 |  |
| :--- | :--- | :--- |
| 1101 | one's complement of 2 | invert |
| 1110 | -2 (two's complement of 2$)$ | +1 |

## Two's complement

| 0010 | 2 |  |
| :--- | :--- | :--- |
| 1101 | one's complement of 2 | invert |
| 1110 | -2 (two's complement of 2) | +1 |
| 0001 | one's complement of -2 | invert |

## Two's complement

| 0010 | 2 |  |
| :--- | :--- | :--- |
| 1101 | one's complement of 2 | invert |
| 1110 | $-2($ two's complement of 2$)$ | +1 |
| 0001 | one's complement of -2 | invert |
| 0010 | $2($ two's complement of -2$)$ | +1 |

## Signed integers

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|  | 1111 | 0000 | 0001 |  |
| :---: | :---: | :---: | :---: | :---: |
|  | $110-1$ | 0 | 1 亿 00 |  |
| 1101 | -2 |  | 2 | 0011 |
|  | -3 |  | 3 |  |
| 1100 | -4 |  |  | 0100 |
|  | -5 |  | 5 |  |
| 1011 | -6 |  | 6 | 0101 |
|  | $1010 \quad-7$ | -8 | 7 |  |
|  | 1001 | 1000 | 0111 |  |

## Goals of the <br> project <br> How a relay <br> works <br> Logic <br> Relay logic <br> Half/Full <br> Adder <br> Signed <br> integers <br> Photos <br> - Add controlled inverter

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## 4 Bit Adder

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## T8



## 8 <br> The backboard



## The lights

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## 5 <br> The wires



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## Facts!

## Goals of the

## Current:

- 90 mA per Relay

■ $\sim 2.6 \mathrm{~A}$

## Frequency:

- 10 ms per Relay

■ Targetfrequency of EuroTwo: $2-4 \mathrm{~Hz}$
Price:
■ Don't ask!

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## Lessons learned

- Backlight illumination is not worth it
- (Data)wires on the front would help explaining how is works!

■ LED Backillumination: Use Cu on the front!
■ Use connectors for the switches

■ Use DPDT Relay for MUX,DEC and Registers

- Better labels for signed calculation! Or now labels at all.
- White PCBs are better!
- Do not solder every single wire $\rightarrow$ screws!


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## Demo

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■ Most of the PCB are planned and layouted. Just need to order.

- ControlUnit (CU) left
- Datawires on the front, connected via screws

■ Powersupply on the back, through mountings
■ No backlight illumination

- PWR LED on the back of each PCB
- Size: $5 \times 5=25$ PCBs


## E9 EuroTwo

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## EuroTwo



## Goals of the

## Questions?

The beamer template is online! https://wiki.vspace.one/lib/exe/fetch.php?media= 20180918_template_presentation.zip

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- [?]

