

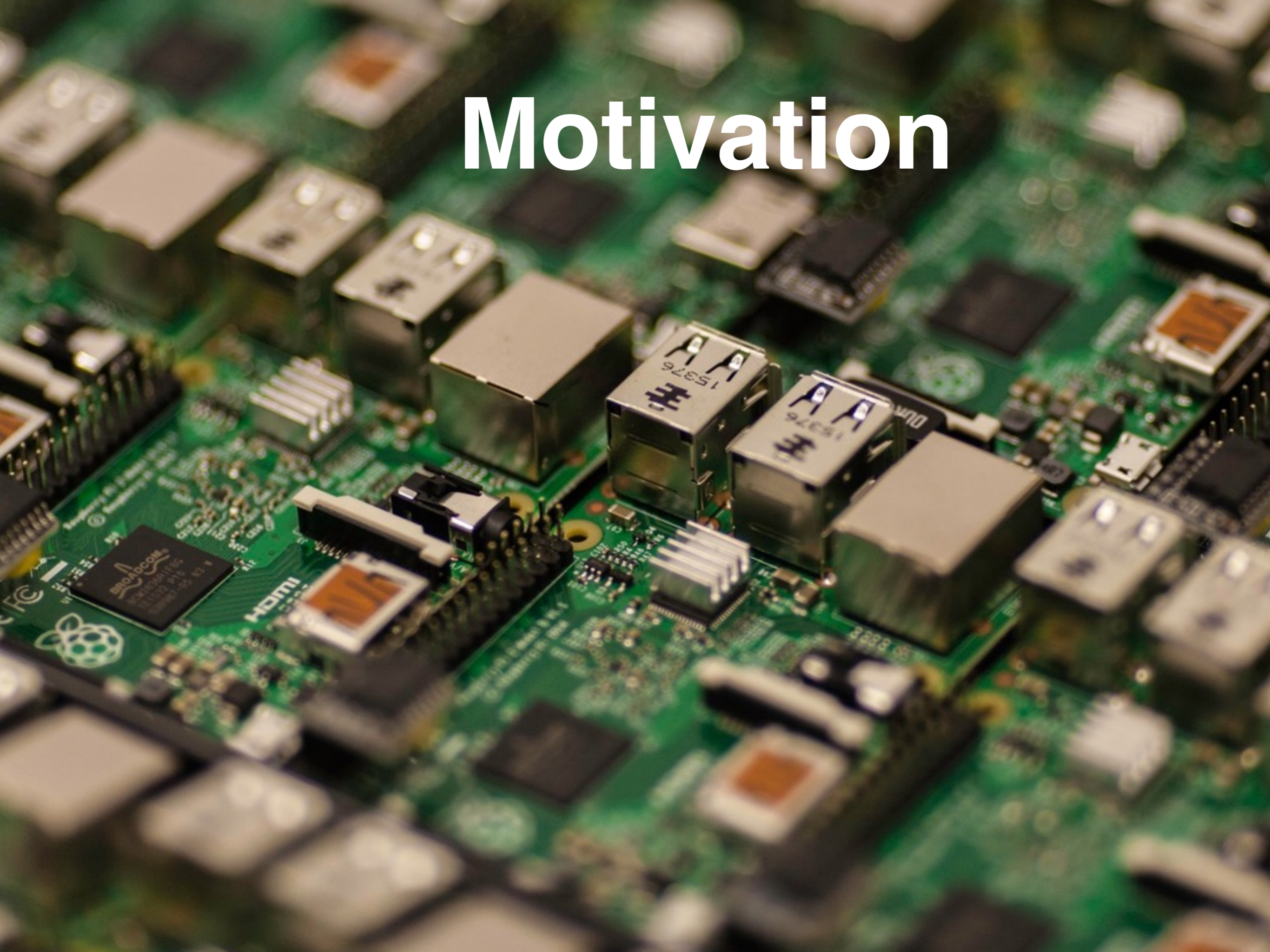
Controlling Machines with Smalltalk on Raspberry Pi

ESUG 2016

Georg Heeg eK

Georg Heeg & Karsten Kusche

Motivation



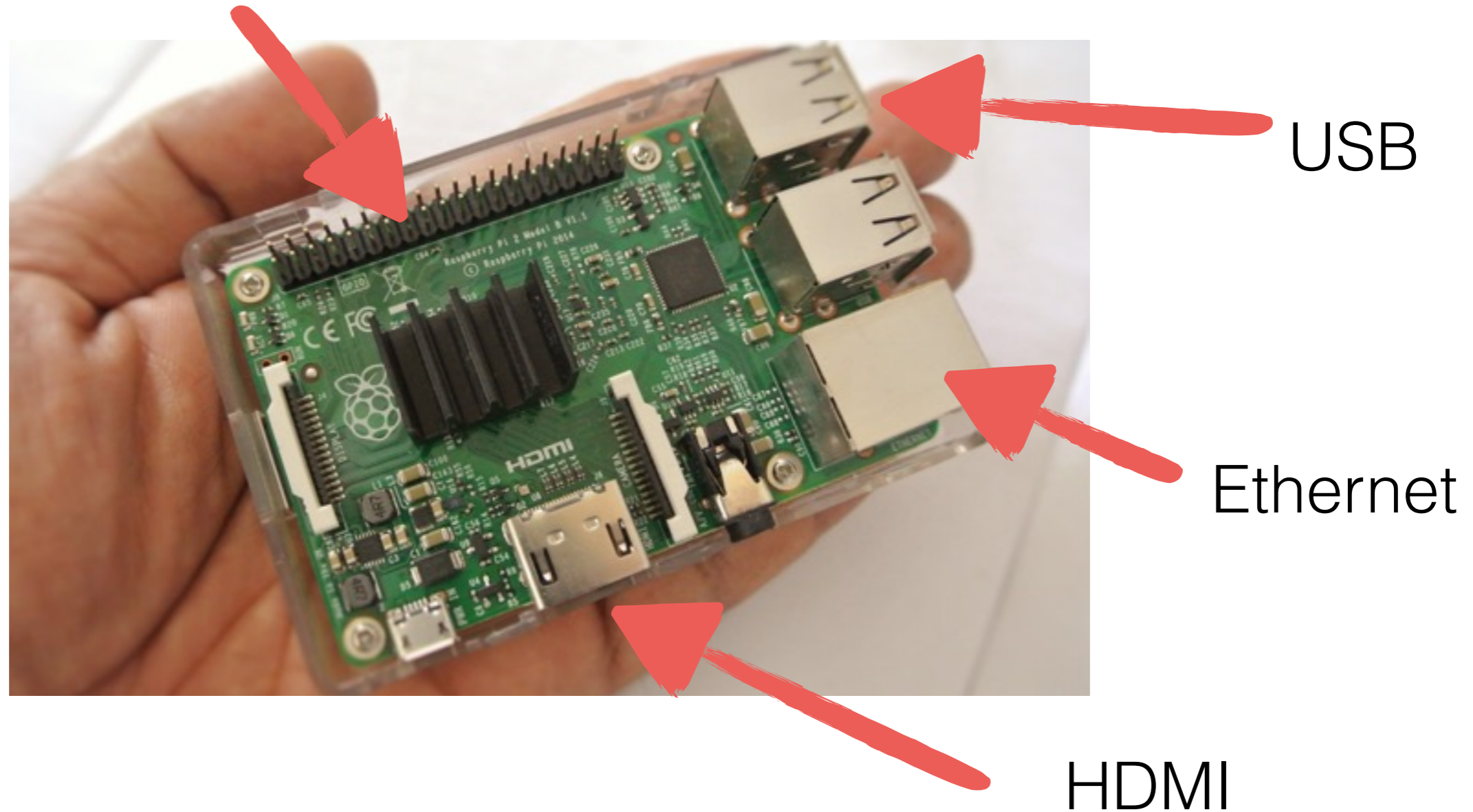
Mundartenstation

(Station of German Dialects)

- Button to start / stop playback
- LED to indicate playback
- MP3 support
- configuration via CSV-Files



26 GPIOs + Power + Ground







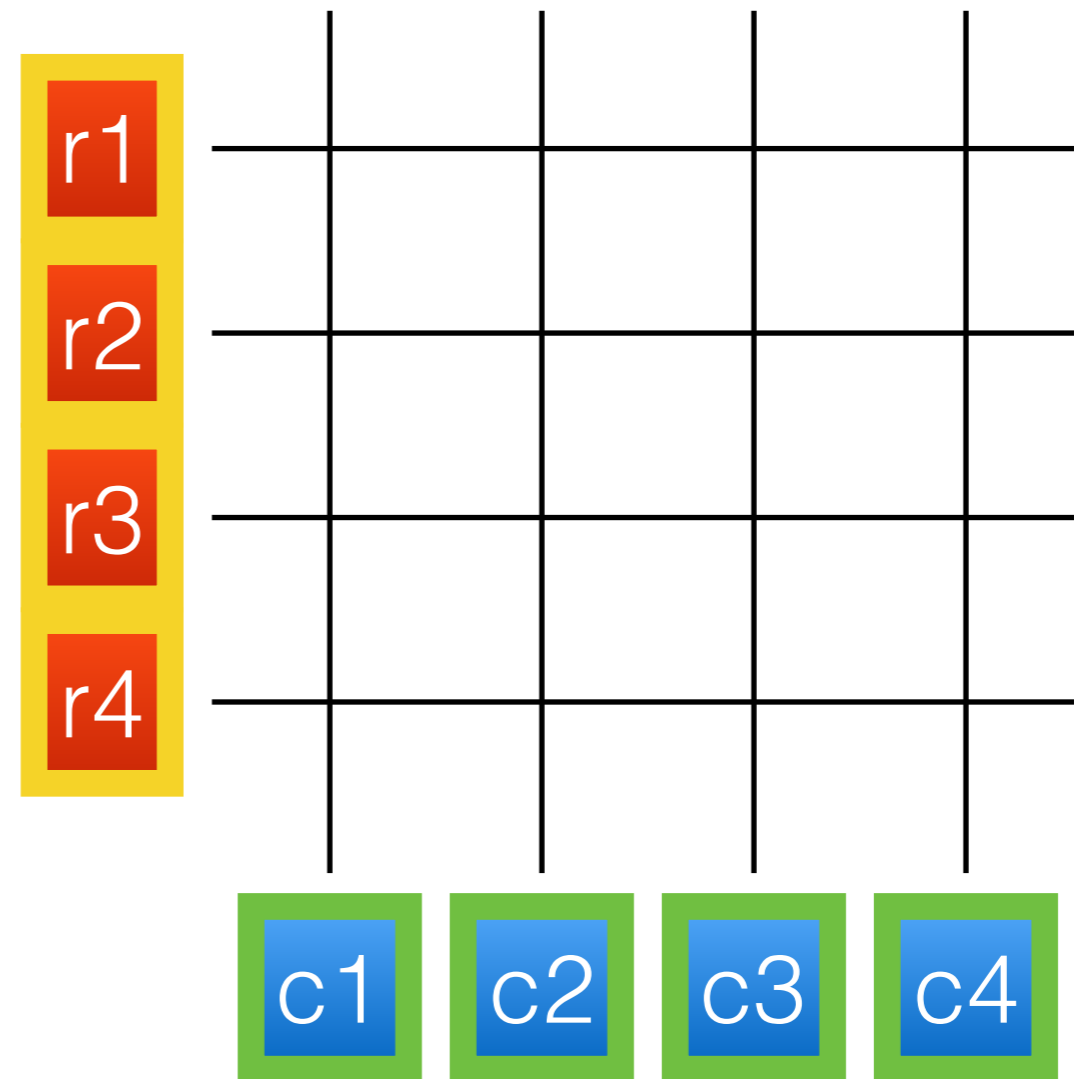
Raspberry Pi

900Mhz Quad-Core ARMv7 @ 1GB RAM

Matrix Circuit





- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols

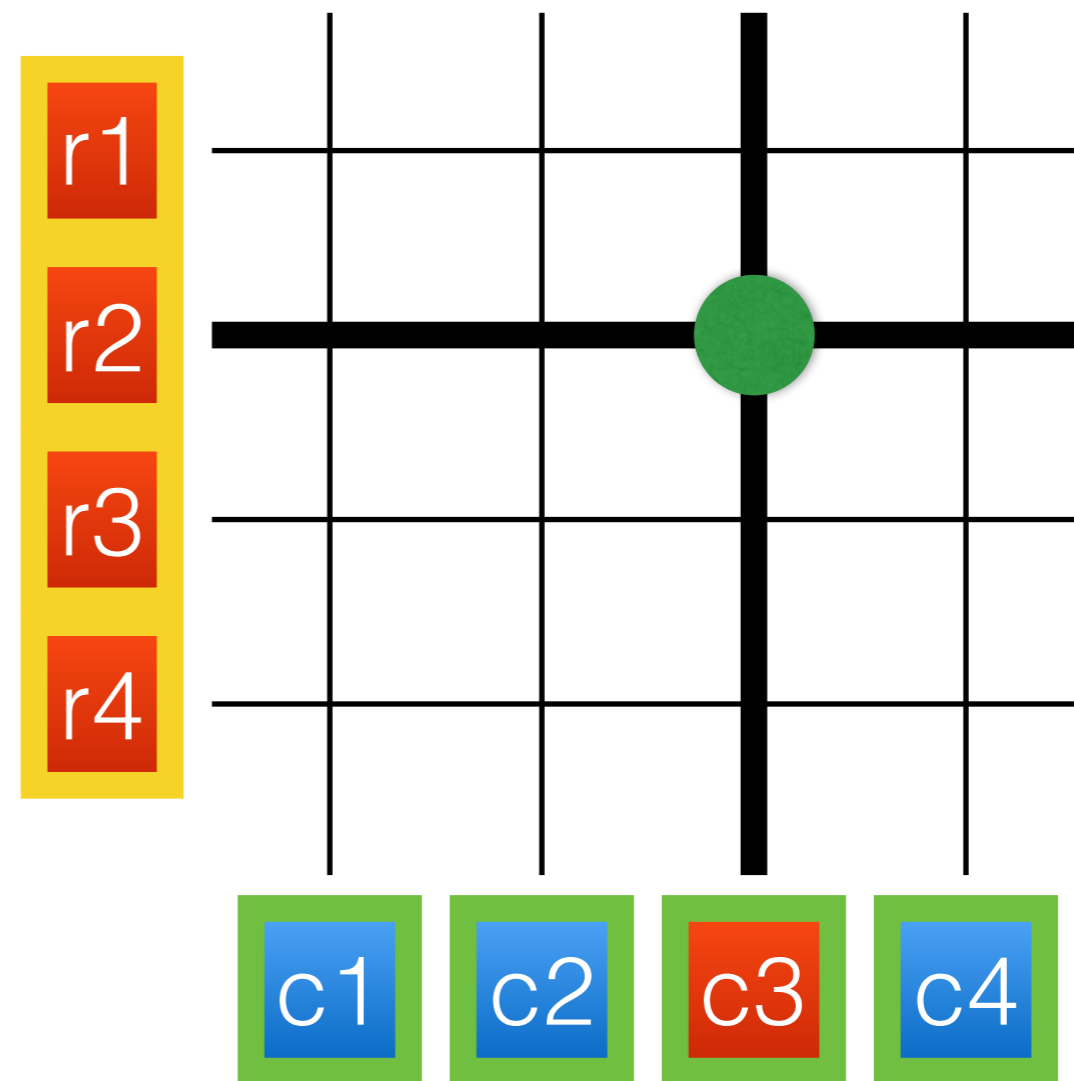
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-  = off
-  = in
-  = out



Matrix Circuit





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- 84 Buttons = 7 rows x 12 cols

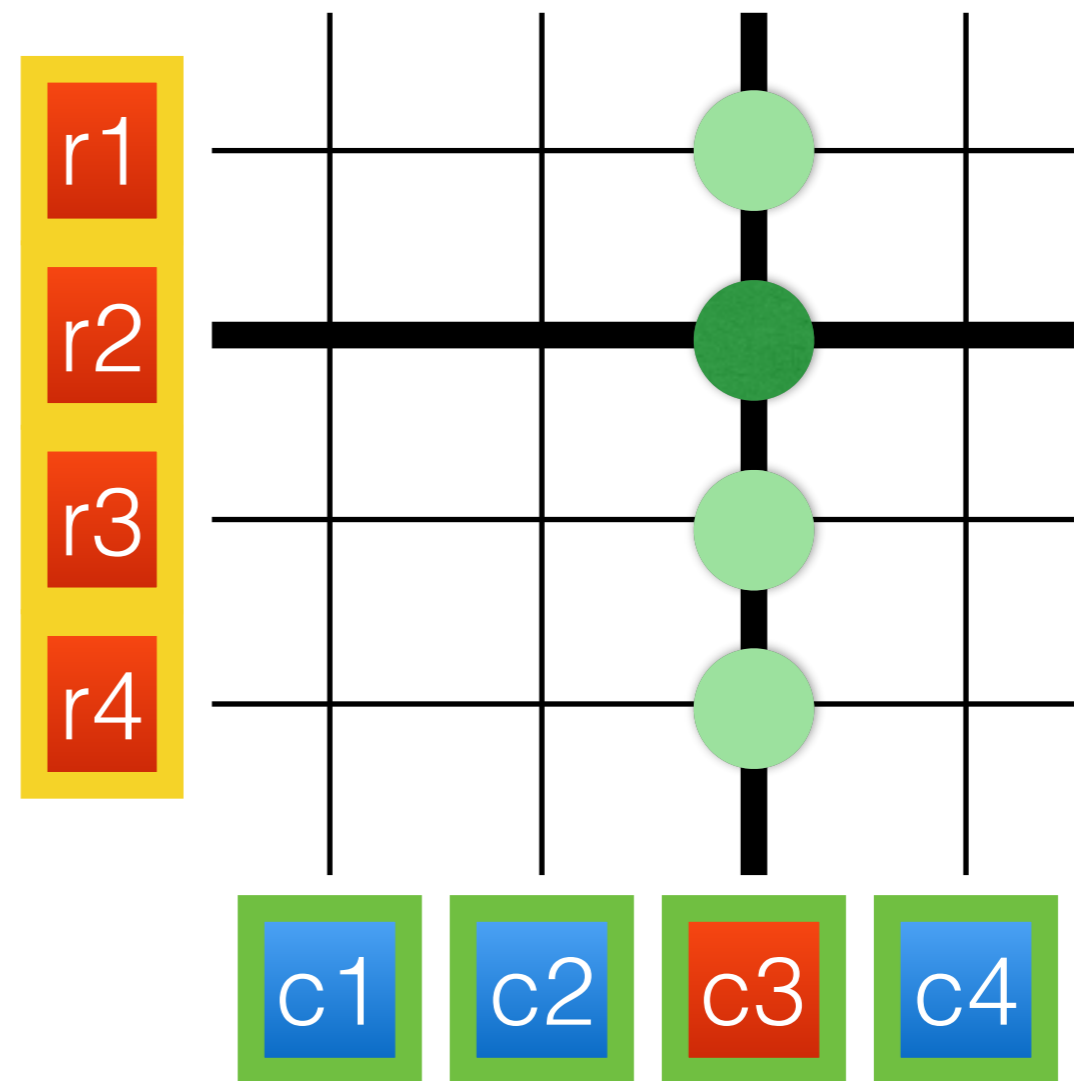
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Matrix Circuit





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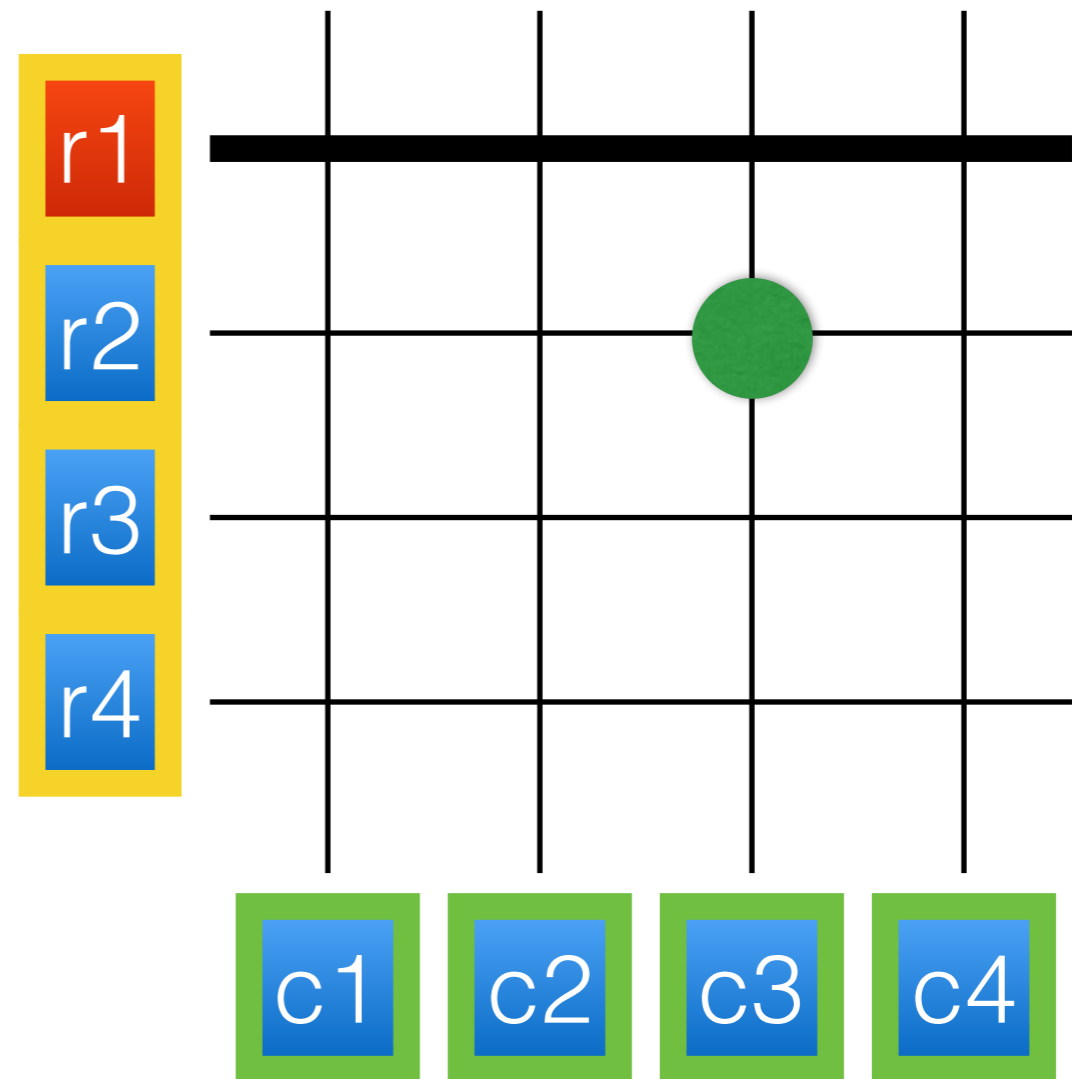
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Matrix Circuit





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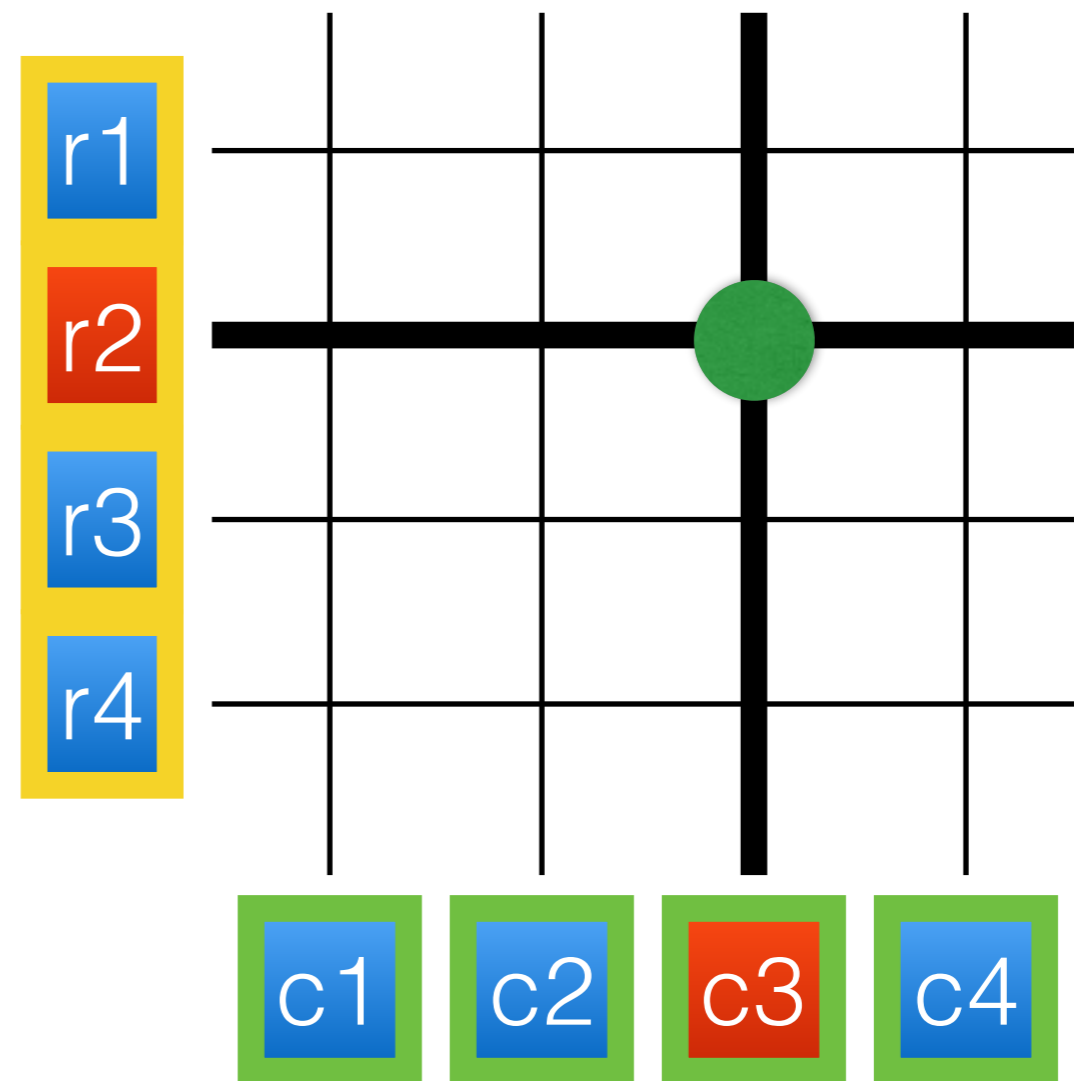
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Matrix Circuit





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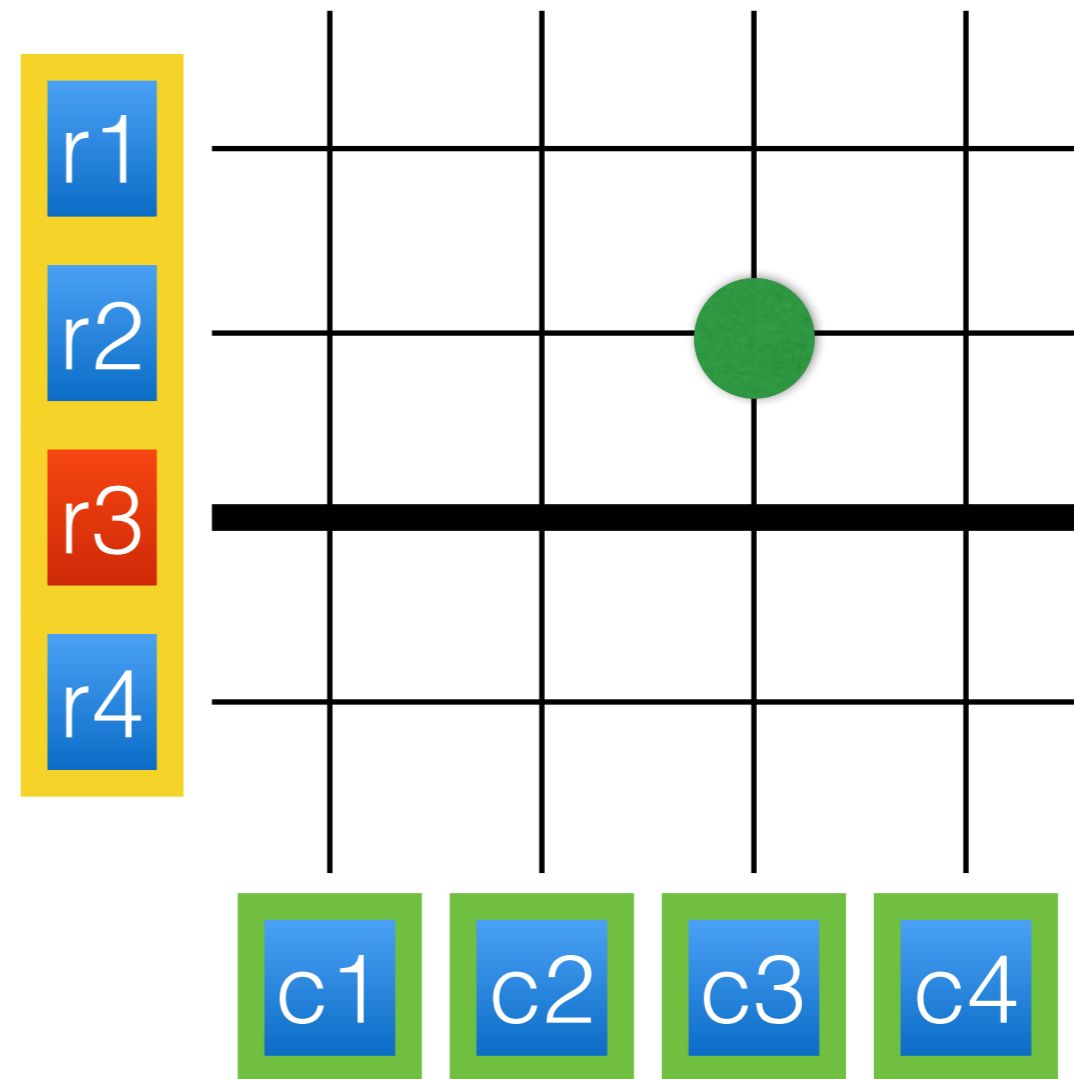
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Matrix Circuit





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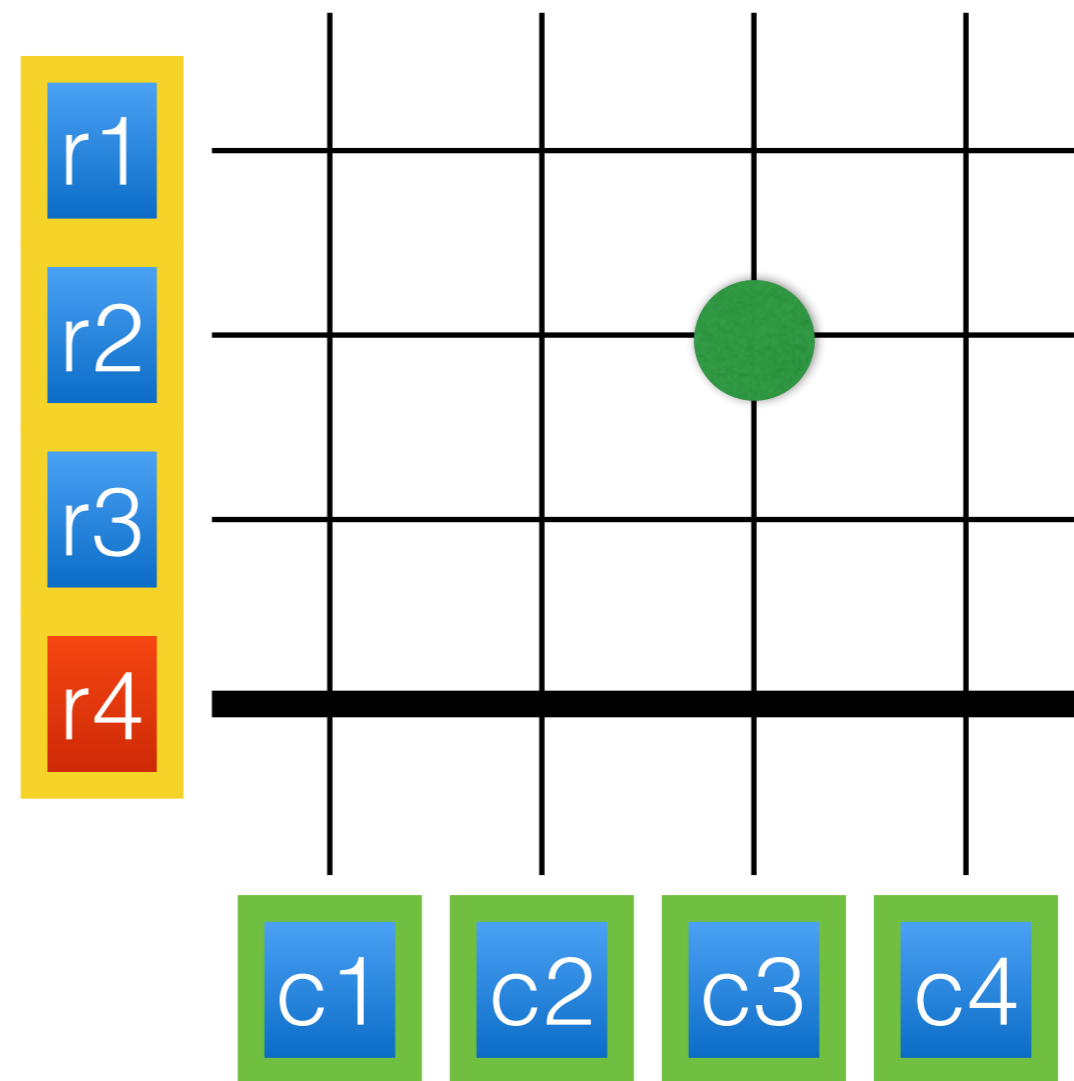
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Matrix Circuit





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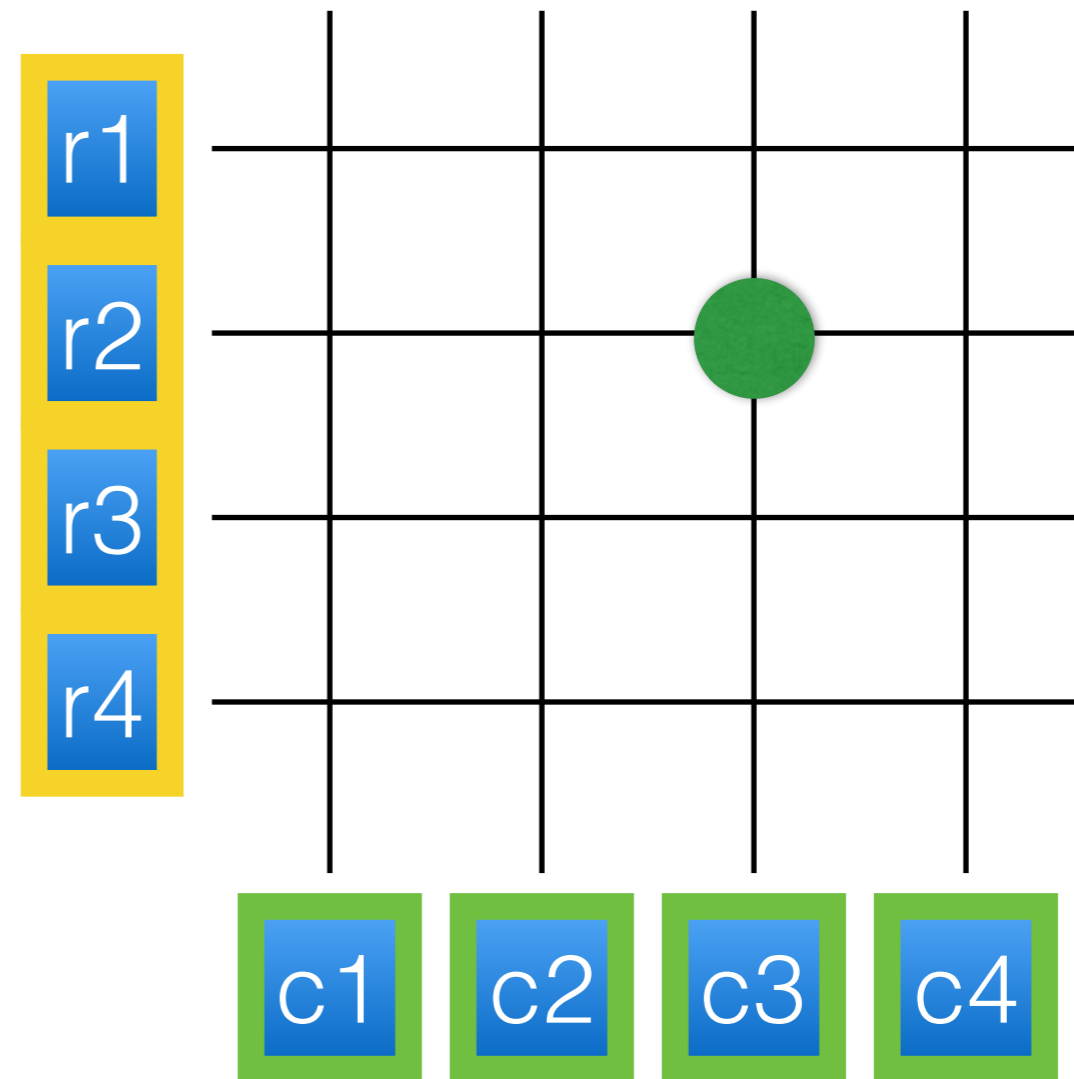
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-  = in
-  = out



Matrix Circuit





- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols

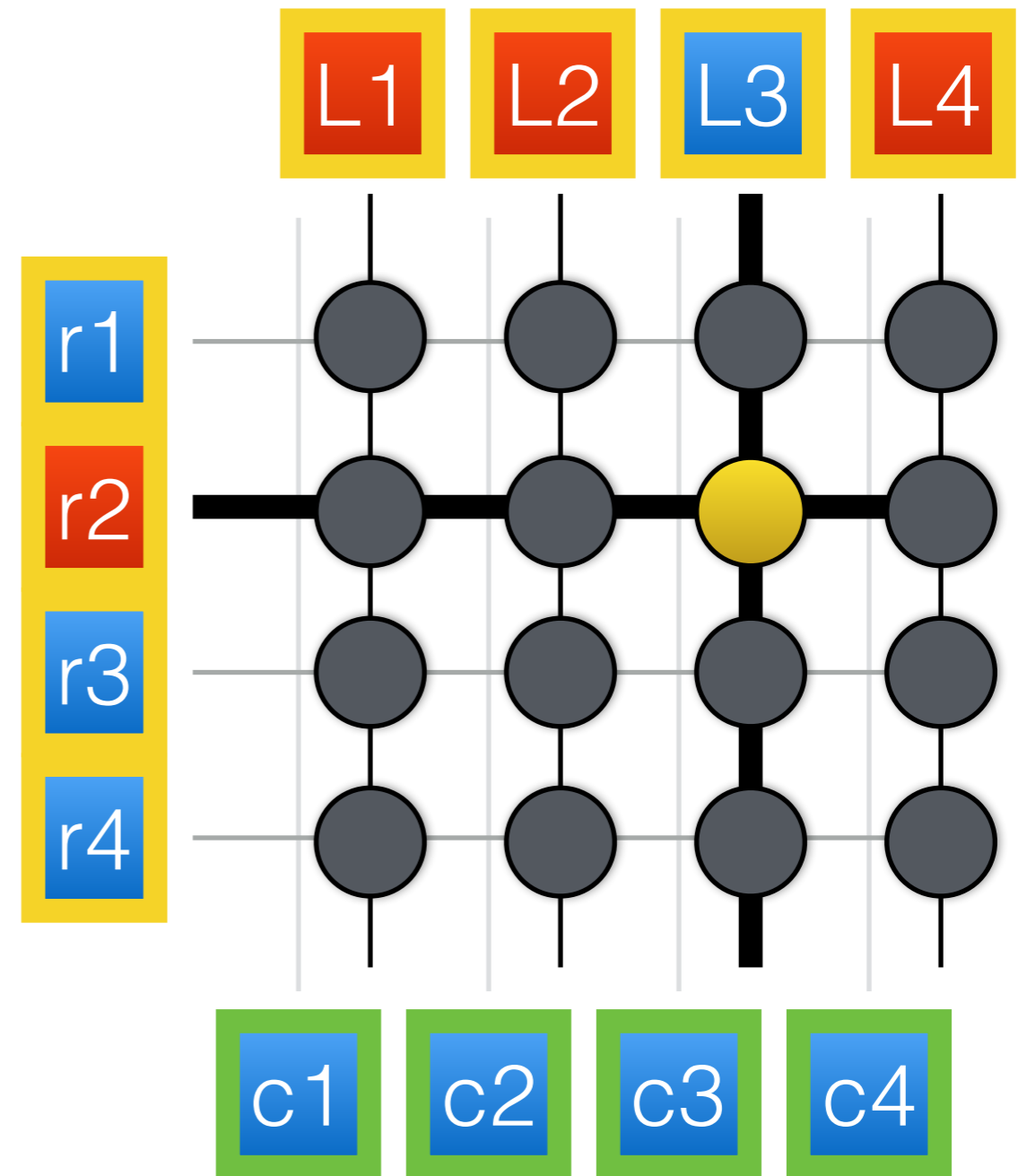
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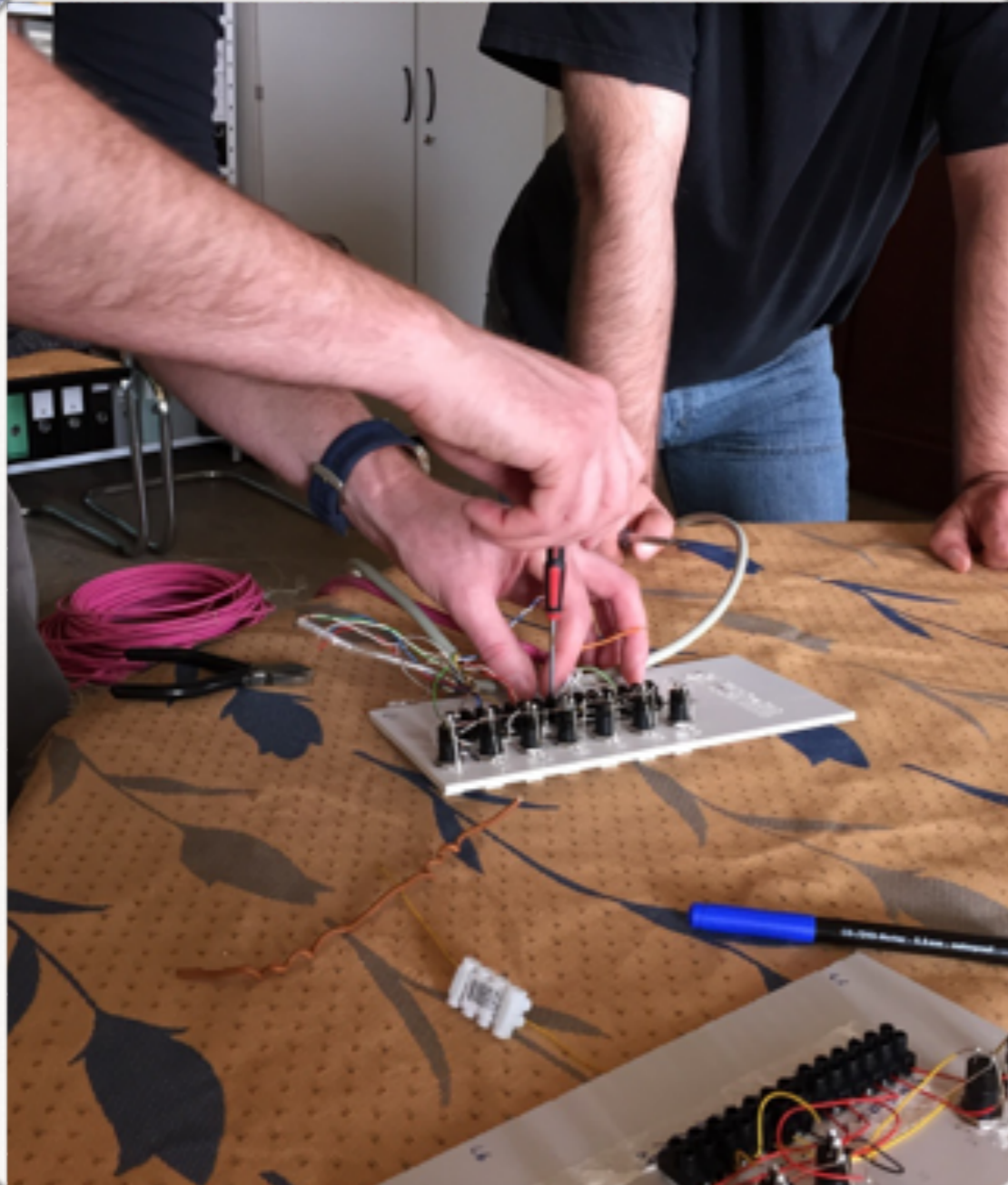
LED Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols

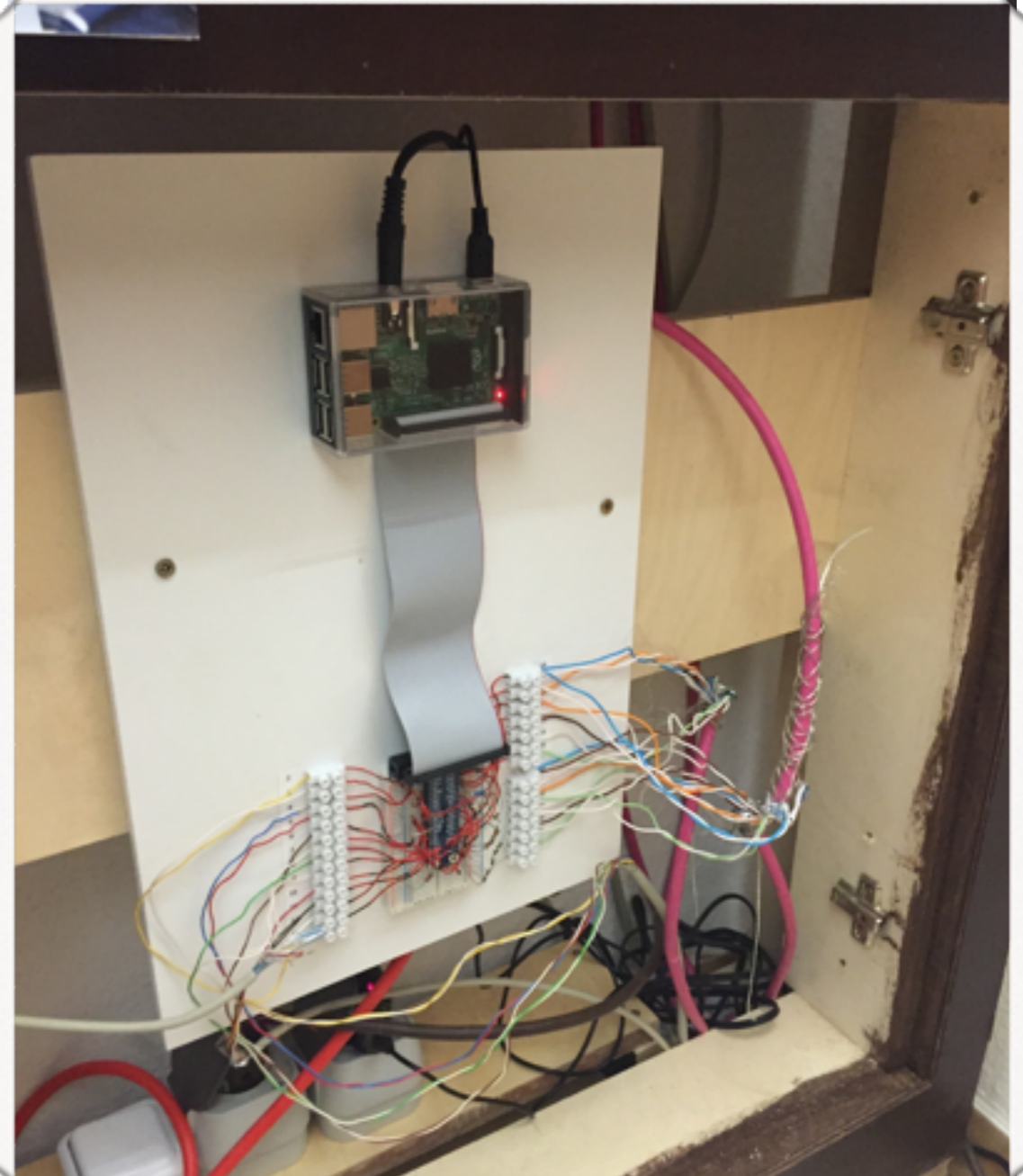
-  = on
-  = off
-  = in
-  = out



Hardware Assembly



Hardware Assembly



GPIO Access

- sysfs in Kernel via `/sys/class/gpio`

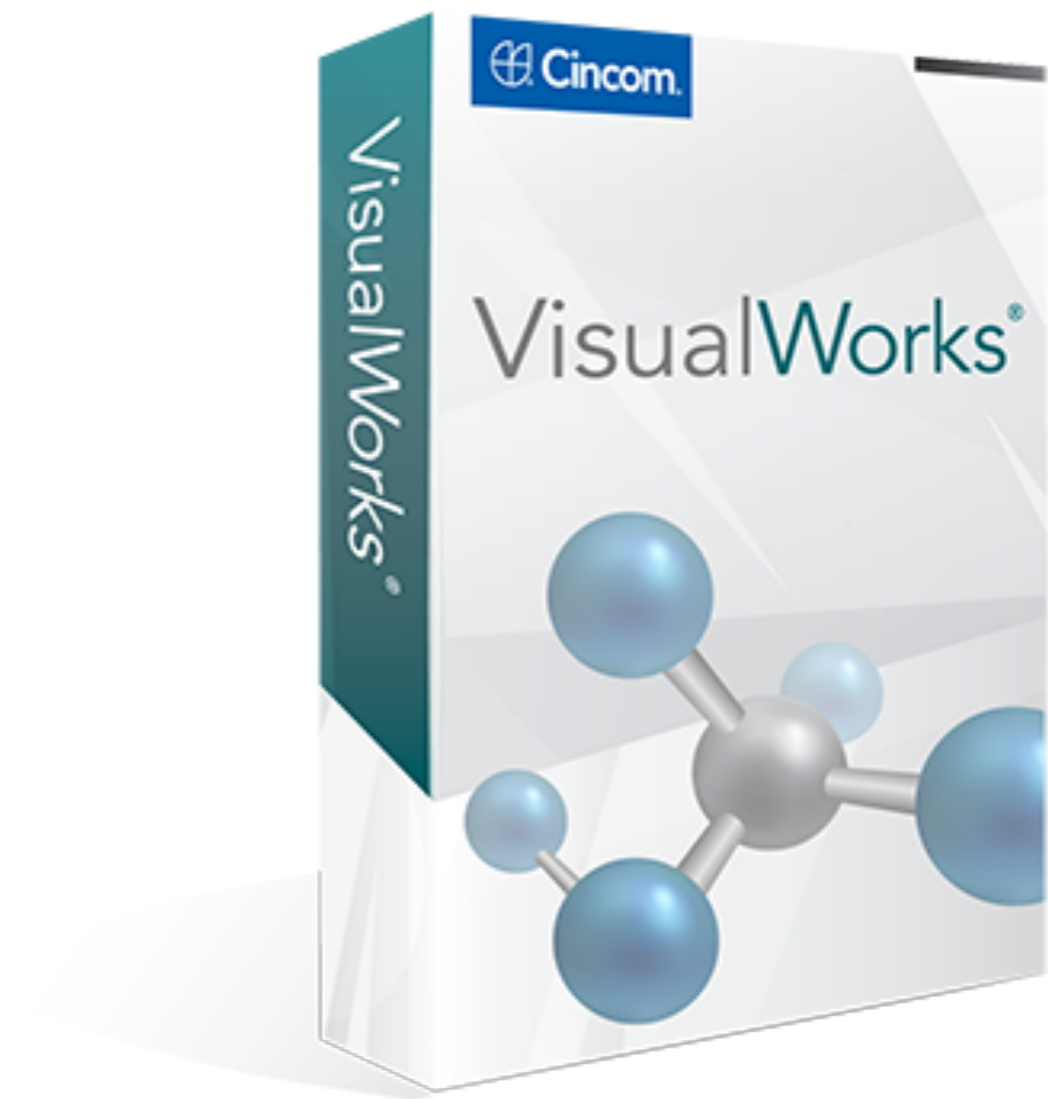
Pin#	NAME		NAME	Pin#
01	3.3v DC Power		DC Power 5v	02
03	GPIO02 (SDA1 , I ² C)		DC Power 5v	04
05	GPIO03 (SCL1 , I ² C)		Ground	06
07	GPIO04 (GPIO_GCLK)		(TXD0) GPIO14	08
09	Ground		(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)		(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)		Ground	14
15	GPIO22 (GPIO_GEN3)		(GPIO_GEN4) GPIO23	16
17	3.3v DC Power		(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)		Ground	20
21	GPIO09 (SPI_MISO)		(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)		(SPI_CE0_N) GPIO08	24
25	Ground		(SPI_CE1_N) GPIO07	26
27	ID_SD (I ² C ID EEPROM)		(I ² C ID EEPROM) ID_SC	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12	32
33	GPIO13		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40

Rev. 1
26/01/2014

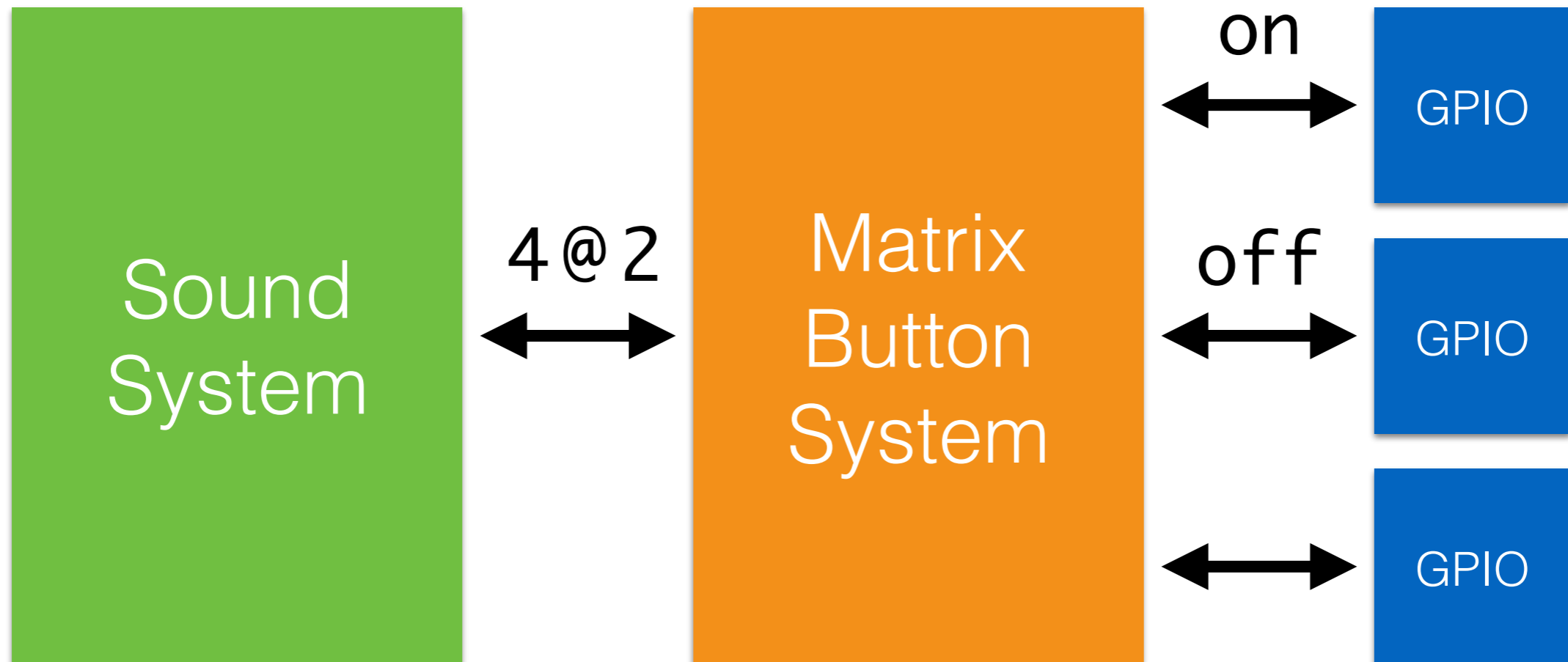
<http://www.element14.com>

How to program the Raspberry Pi?

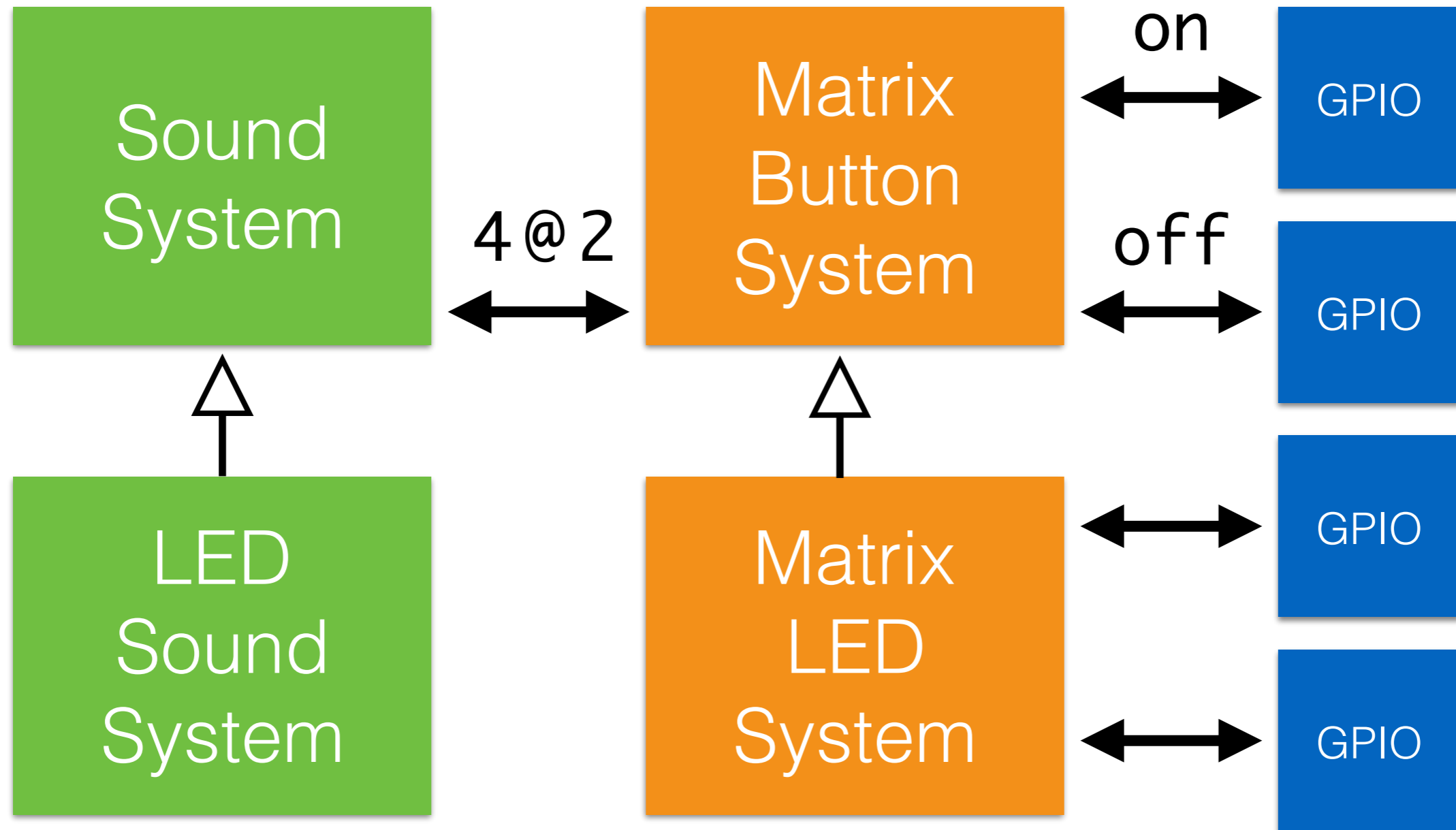
- Cincom® is Cosponsor of Erlebniswelt Deutsche Sprache
- Initial Port of VisualWorks® VM within 5 Days



VisualWorks



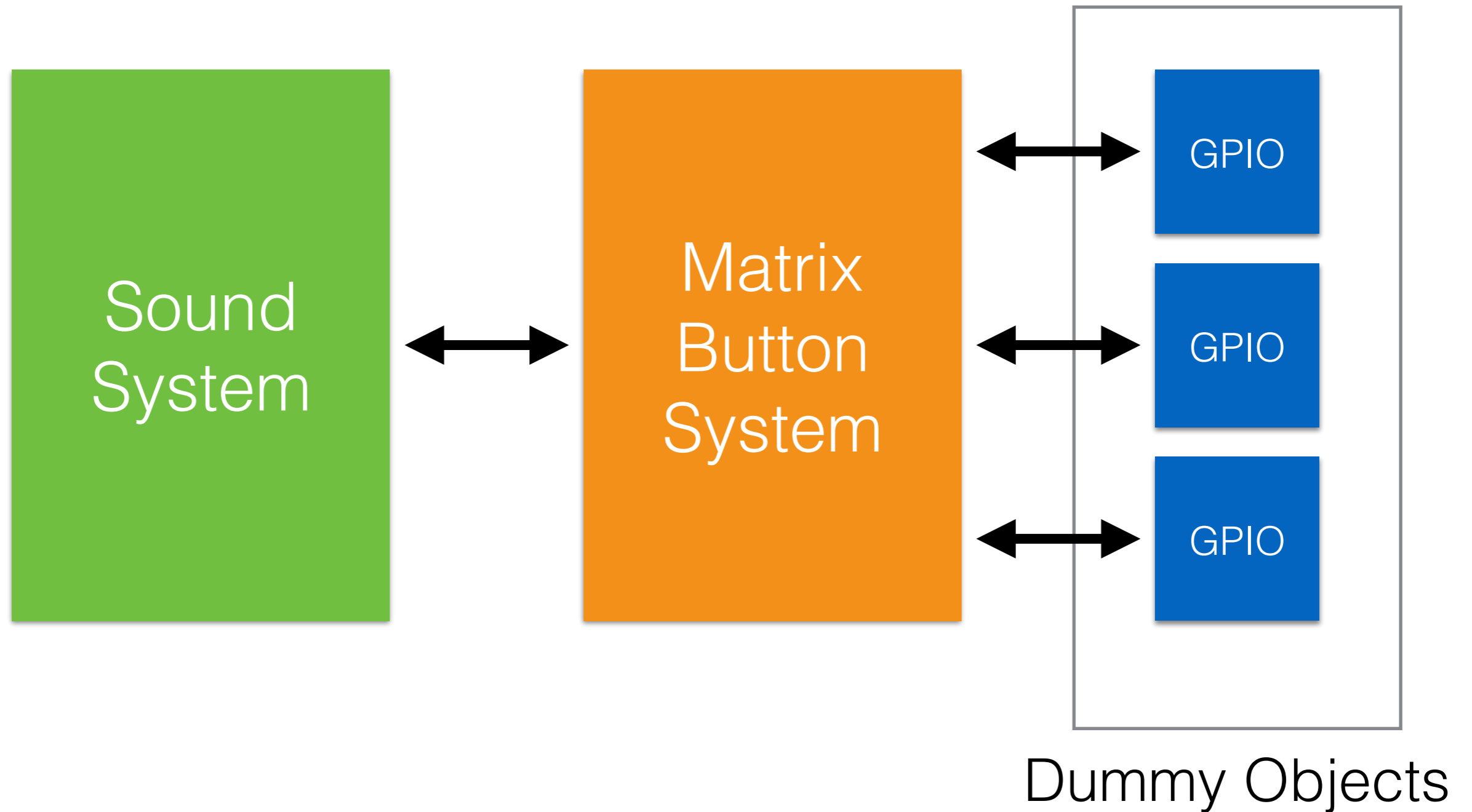
VisualWorks



Sound System

1. Wait for Any Button-Press
2. Play Track
3. Wait for Button-Release
4. Wait for End of Track or Same Button-Press
5. Wait for Button-Release
6. Repeat

Testing on Windows



Developer Tools

Raspberry Pi2 GPIO Header

Pin#	NAME		NAME	Pin#
01	3.3v DC Power		DC Power 5v	02
03	GPIO02 (SDA1 , I ² C)		DC Power 5v	04
05	GPIO03 (SCL1 , I ² C)		Ground	06
07	GPIO04 (GPIO_GCLK)		(TXD0) GPIO14	08
09	Ground		(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)		(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)		Ground	14
15	GPIO22 (GPIO_GEN3)		(GPIO_GEN4) GPIO23	16
17	3.3v DC Power		(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)		Ground	20
21	GPIO09 (SPI_MISO)		(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)		(SPI_CE0_N) GPIO08	24
25	Ground		(SPI_CE1_N) GPIO07	26
27	ID_SD (I ² C ID EEPROM)		(I ² C ID EEPROM) ID_SC	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12	32
33	GPIO13		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40



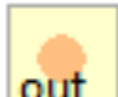
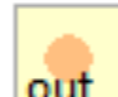






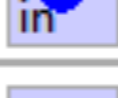
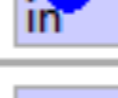
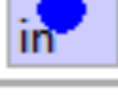
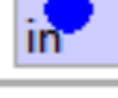
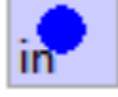
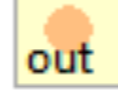

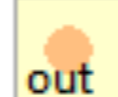
Rev. 1
26/01/2014

<http://www.element14.com>

Raspberry Pi 2

File	GPIO	Sorting	Help				
1	3.3v DC Power			3.3v DC Power			17
2	5v DC Power			5v DC Power			4
34	Ground			Ground			6
30	Ground			Ground			9
25	Ground			Ground			20
39	Ground			Ground			14
28	ID_SC (I ² C ID EEPROM)			ID_SD (I ² C ID EEPROM)			27
3	GPIO02 (SDA1 I ² C)			GPIO03 (SCL1 I ² C)			5
7	GPIO04 (GPIO_GCLK)			GPIO05			29
31	GPIO06			GPIO07 (SPI_CE1_N)			26
24	GPIO08 (SPI_CE0_N)			GPIO09 (SPI_MISO)			21
19	GPIO10 (SPI_MOSI)			GPIO11 (SPI_CLK)			23
32	GPIO012			GPIO13			33
8	GPIO14 (TXD0)			GPIO15 (RXD0)			10
36	GPIO16			GPIO17 (GPIO_GEN0)			11
12	GPIO18 (GPIO_GEN1)			GPIO19			35
38	GPIO20			GPIO21			40
15	GPIO22 (GPIO_GEN3)			GPIO23 (GPIO_GEN4)			16
18	GPIO24 (GPIO_GEN5)			GPIO25 (GPIO_GEN6)			22
37	GPIO26			GPIO27 (GPIO_GEN2)			13

Developer Tools

24	GPIO08 (SPI_CE0_N)			GPIO09 (SPI_MISO)	21
19	GPIO10 (SPI_MOSI)			GPIO11 (SPI_CLK)	23
32	GPIO012			GPIO13	33
8	GPIO14 (TXD0)			GPIO15 (RXD0)	10
36	GPIO16			GPIO17 (GPIO_GEN0)	11
12	GPIO18 (GPIO_GEN1)			GPIO19	35
38	GPIO20			GPIO21	40
15	GPIO22 (GPIO_GEN3)			GPIO23 (GPIO_GEN4)	16
18	GPIO24 (GPIO_GEN5)			GPIO25 (GPIO_GEN6)	22



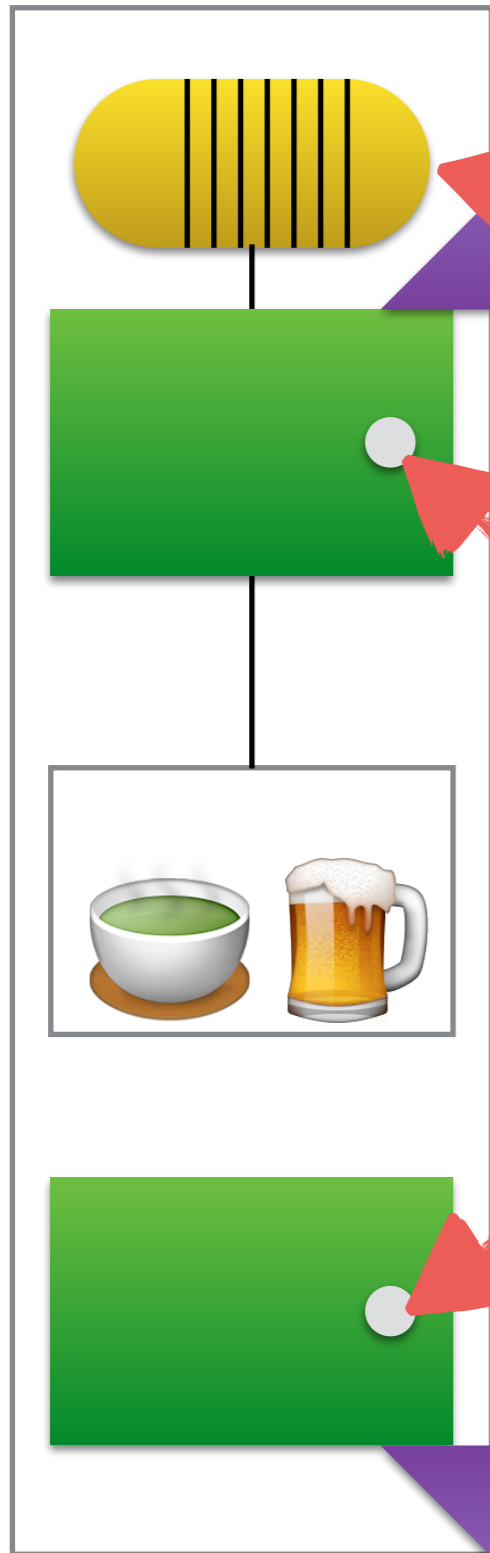
Home Automation

the Heeg way

Kitchen Lift



The Lift



Motor with Windlass

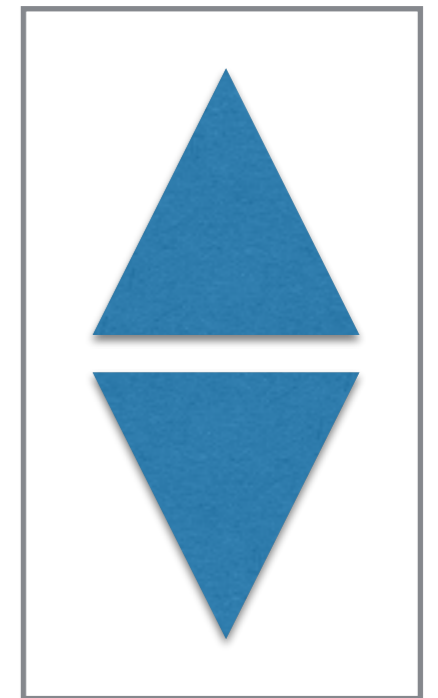
Top Contact

Door Contact 1

Controls

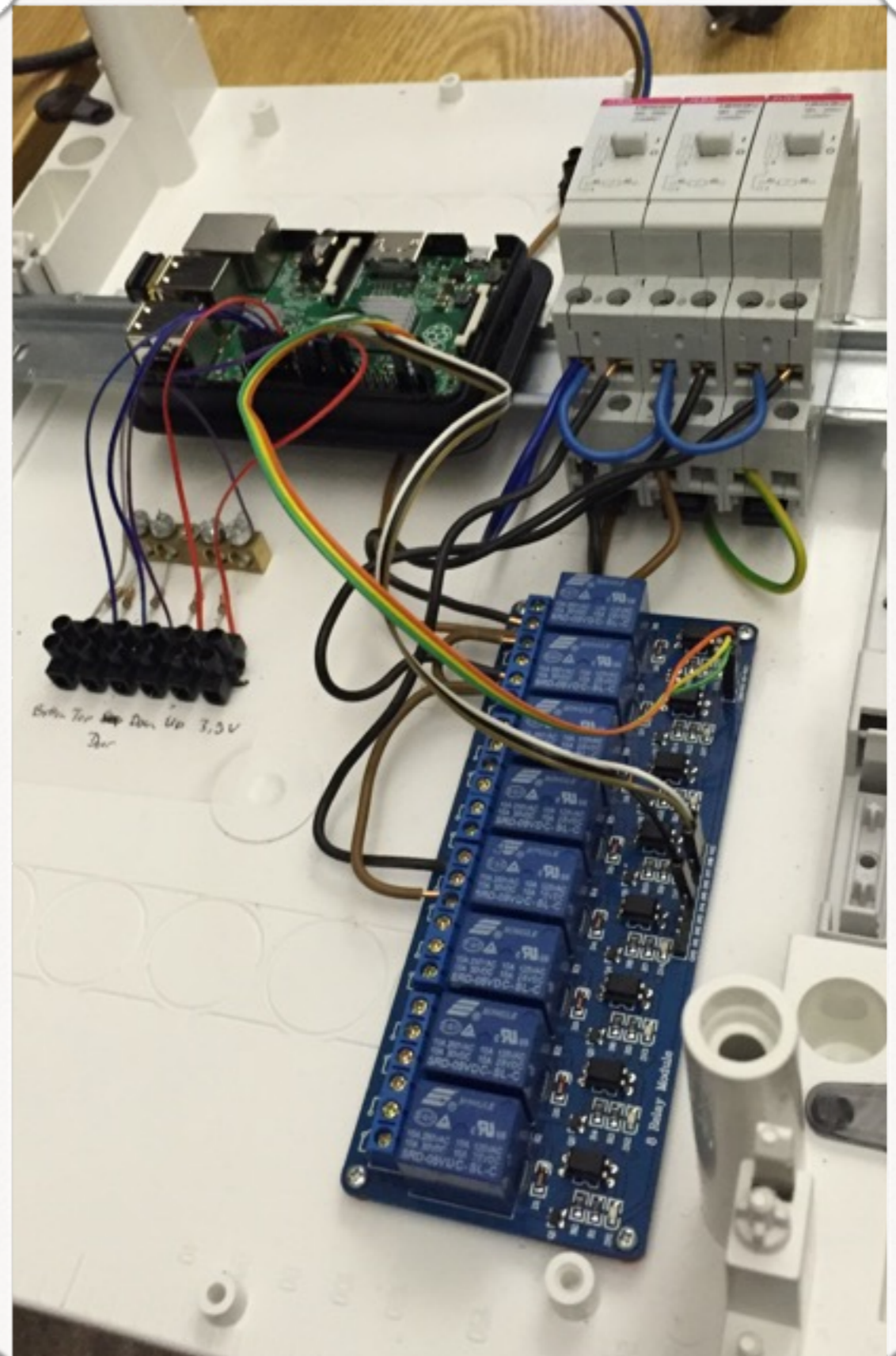
Door Contact 2

Bottom Contact

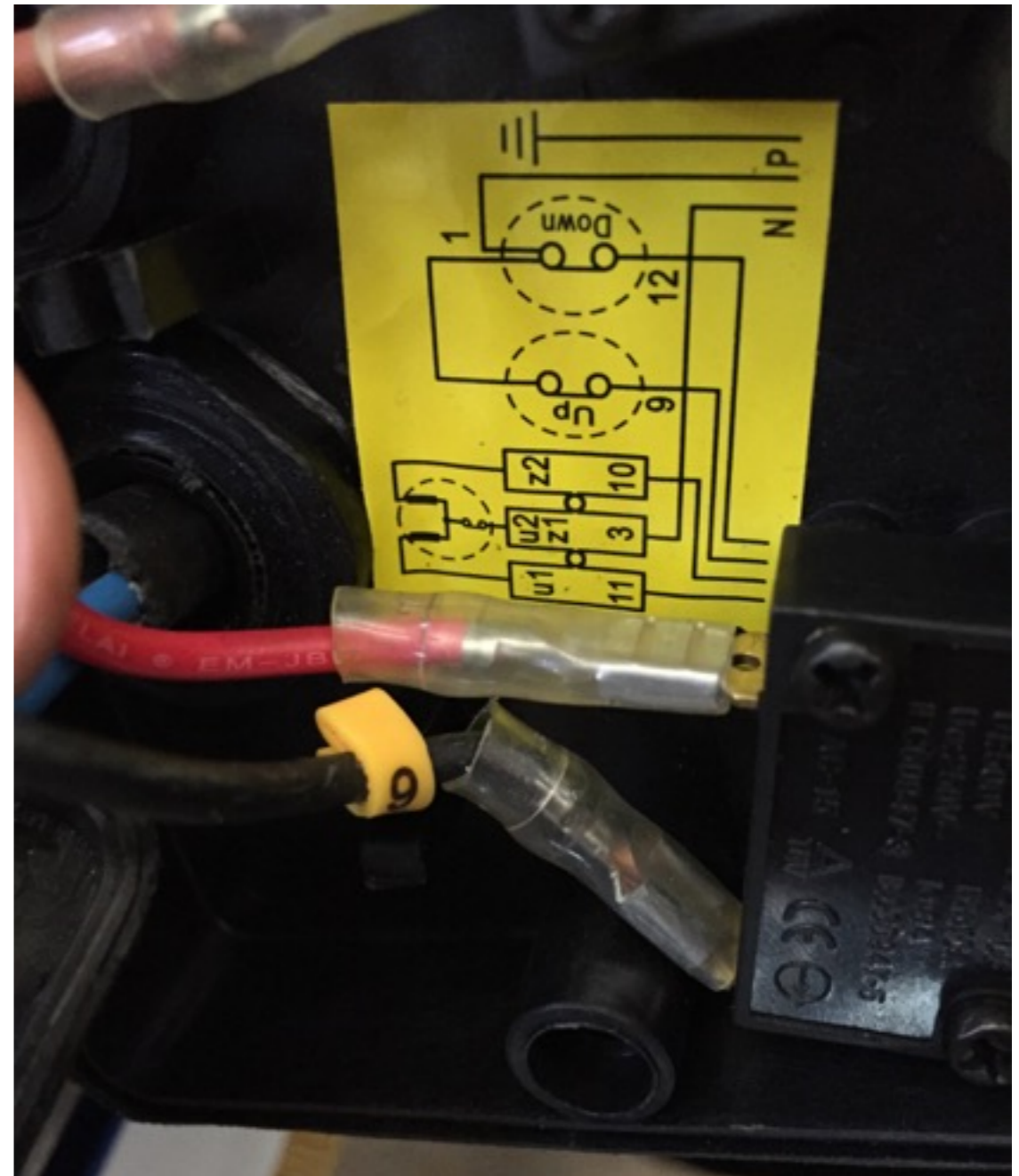


Connecting 220V

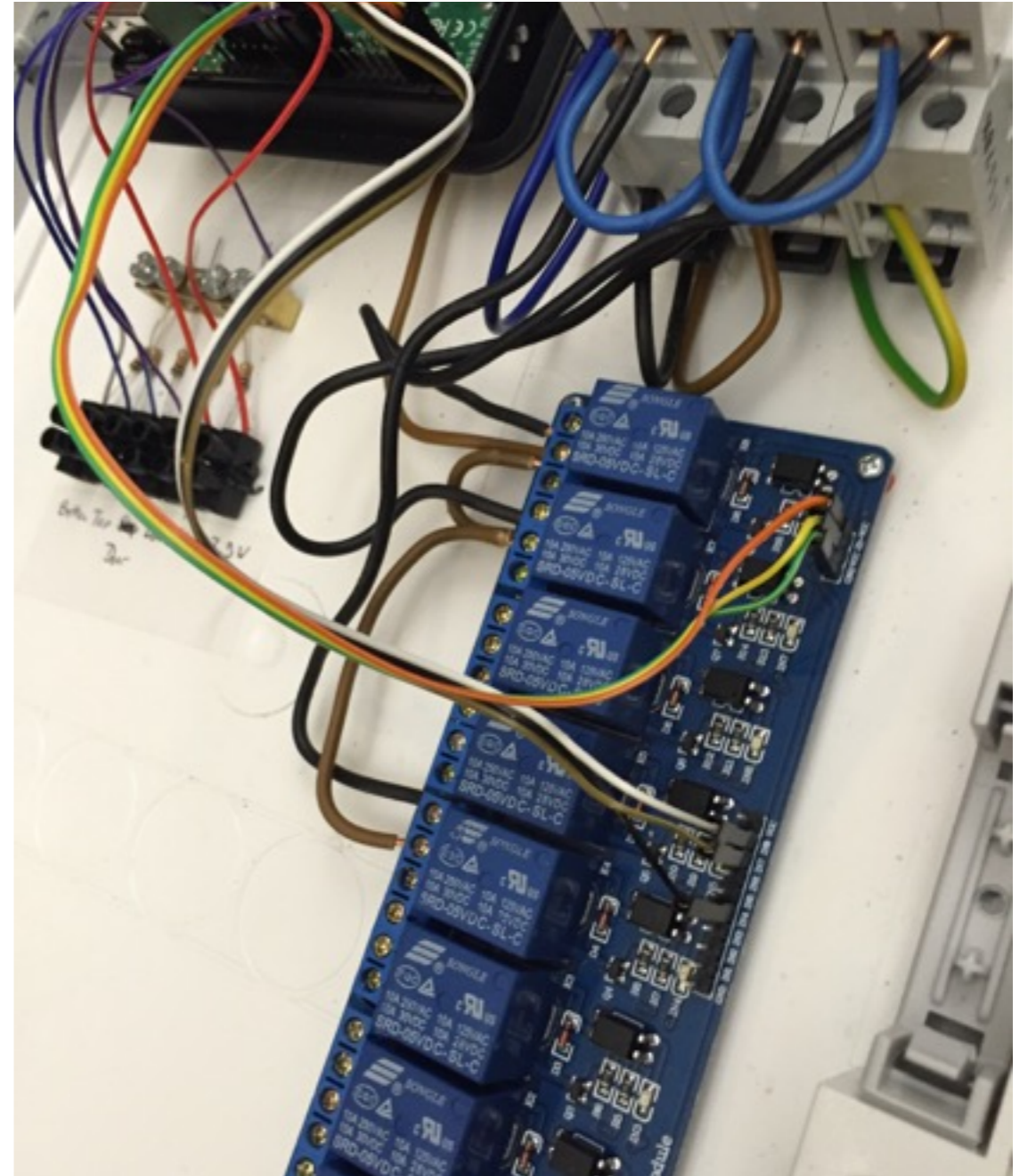
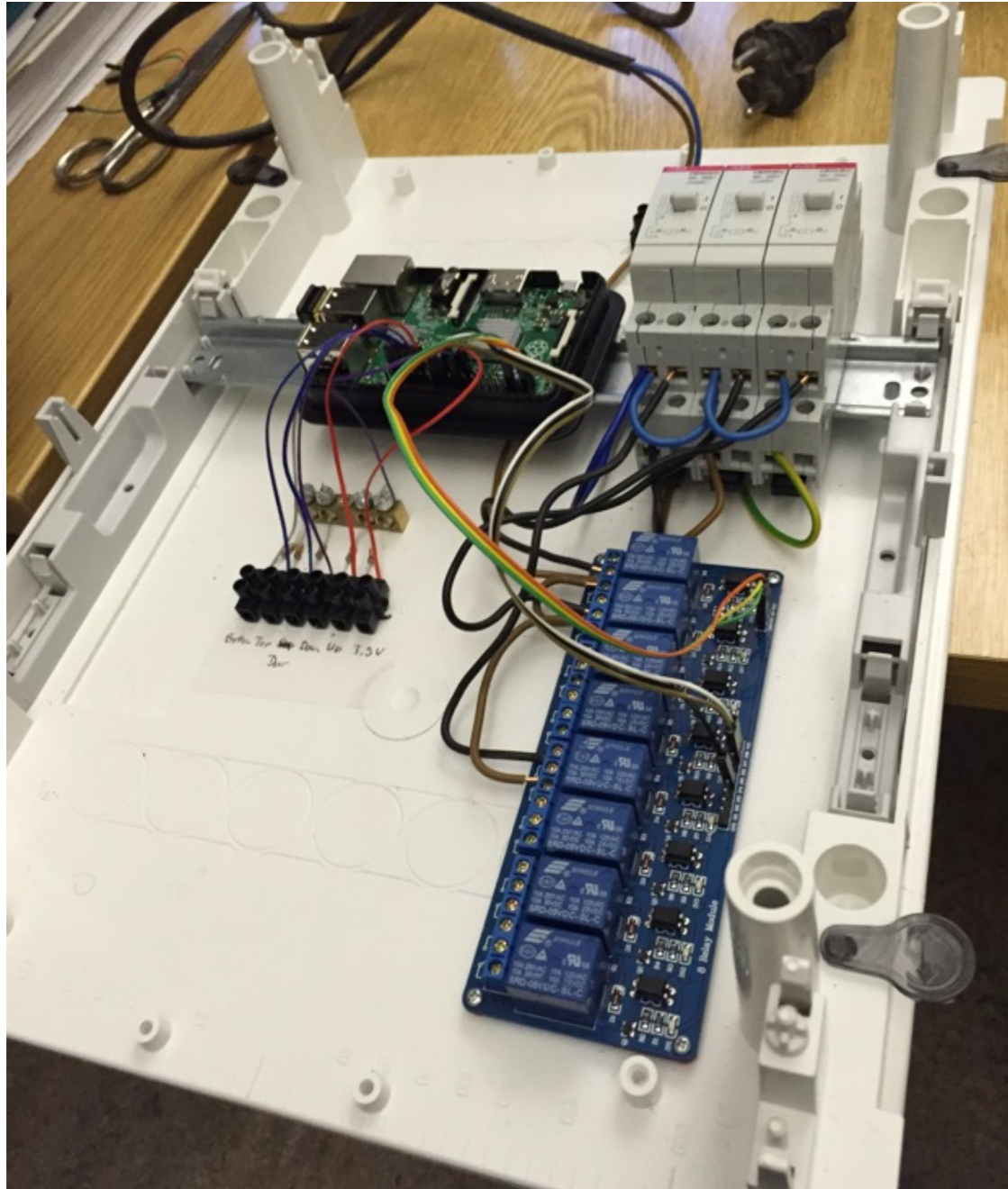
- Relays to switch via GPIO
- Contactor to switch Motor
- Relay switches Contactor



Hardware Assembly



Hardware Assembly



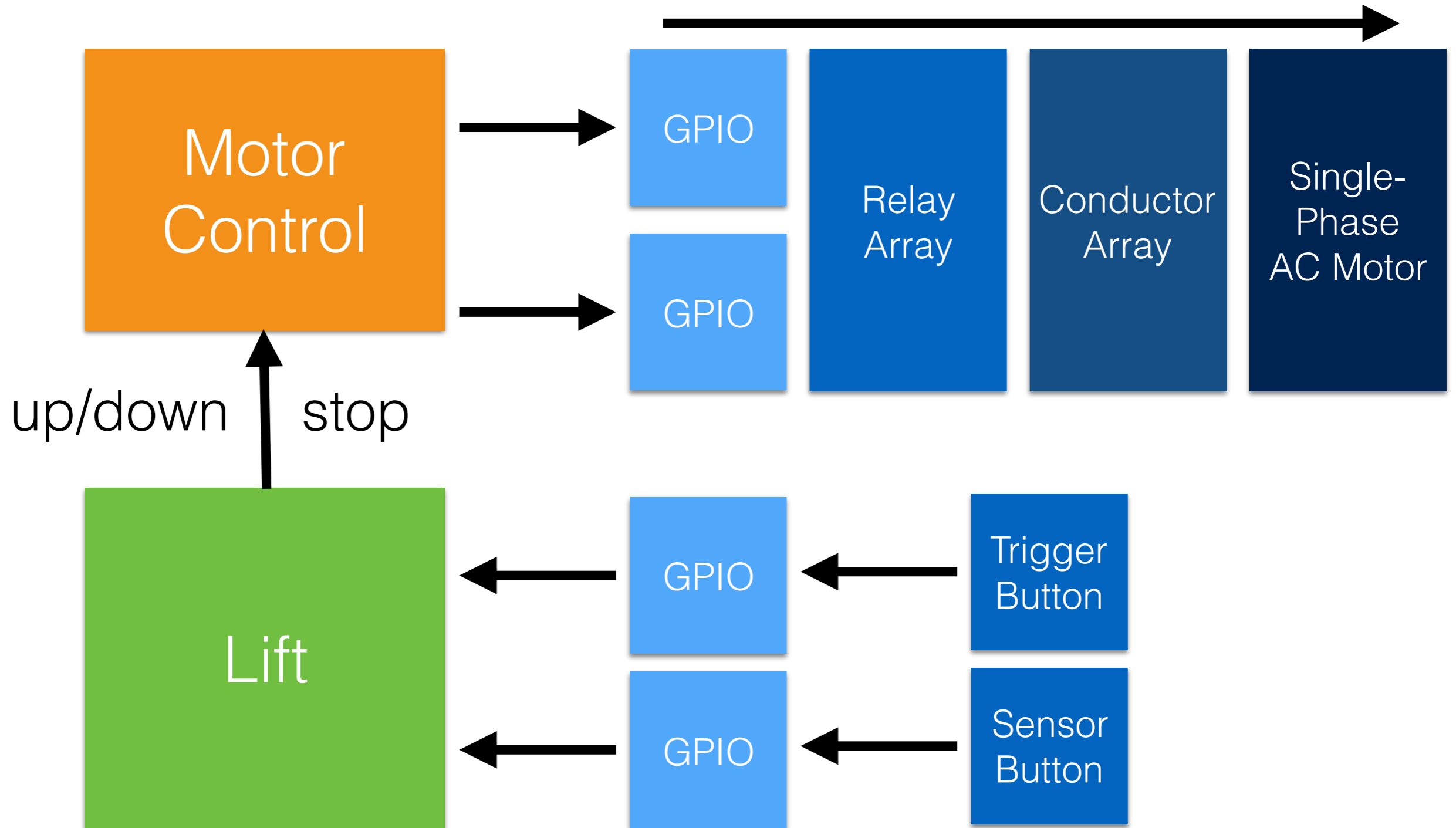
Hardware Assembly



Hardware Assembly



Software Model

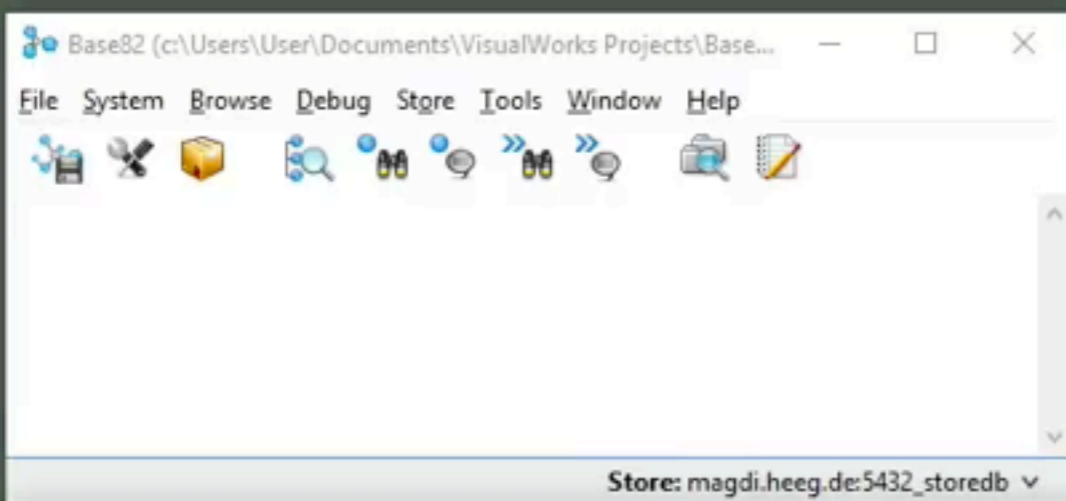


5 Software Rules

- Door open \Rightarrow Stop
- Driving Up \wedge Top Contact \Rightarrow Stop
- Driving Down \wedge Bottom Contact \Rightarrow Stop
- \neg Driving \wedge \neg Bottom Contact \wedge Control Down
 \Rightarrow Drive Down
- \neg Driving \wedge \neg Top Contact \wedge Control Up
 \Rightarrow Drive Up

Demo

- Controlling the Lift from a Workspace
- Using Model Objects for Buttons



LiftApplication

Browser Edit Find View History Package Class Protocol Method Tools Help

Find: liftap

Package	Class	Instance	Class	Shared Variable	Instance Variable
Base VisualWorks		6	initialize-release		initialize
Glorp					isActive
Mundartensystem					name
GPIO					openSimulationWorkspace
GPIO-Examples					startup
GPIO-Monitor					tearDown
Lift					
Mundartensystem-Editc					

Comment Definition Rewrite Code Critic Watches

LiftApplication is used to control the lift

Usage

```
self openForSimulation
```

Instance Variables:

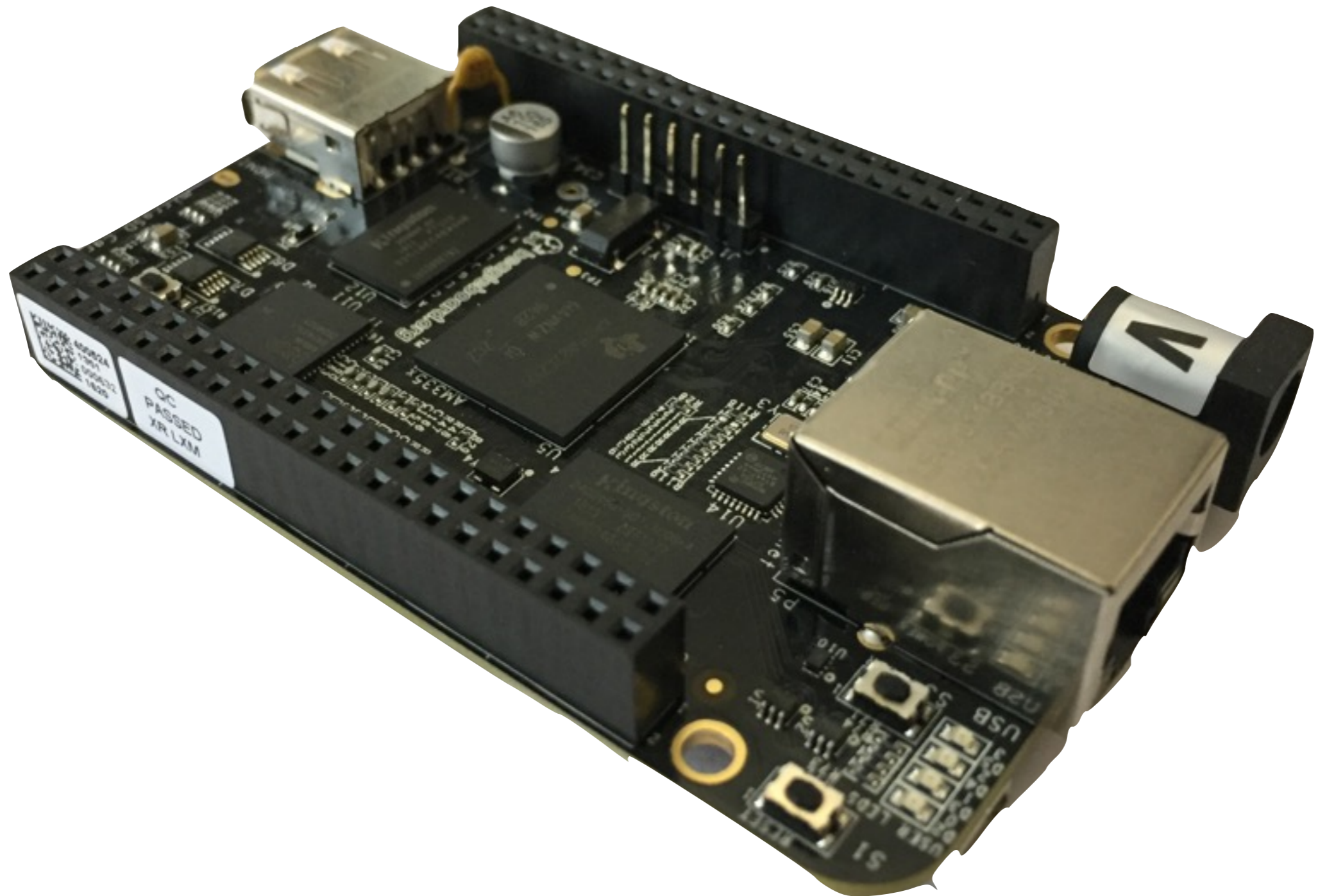
```
lift <Lift>
```

Class: LiftApplication in (Heeg) Package: Lift

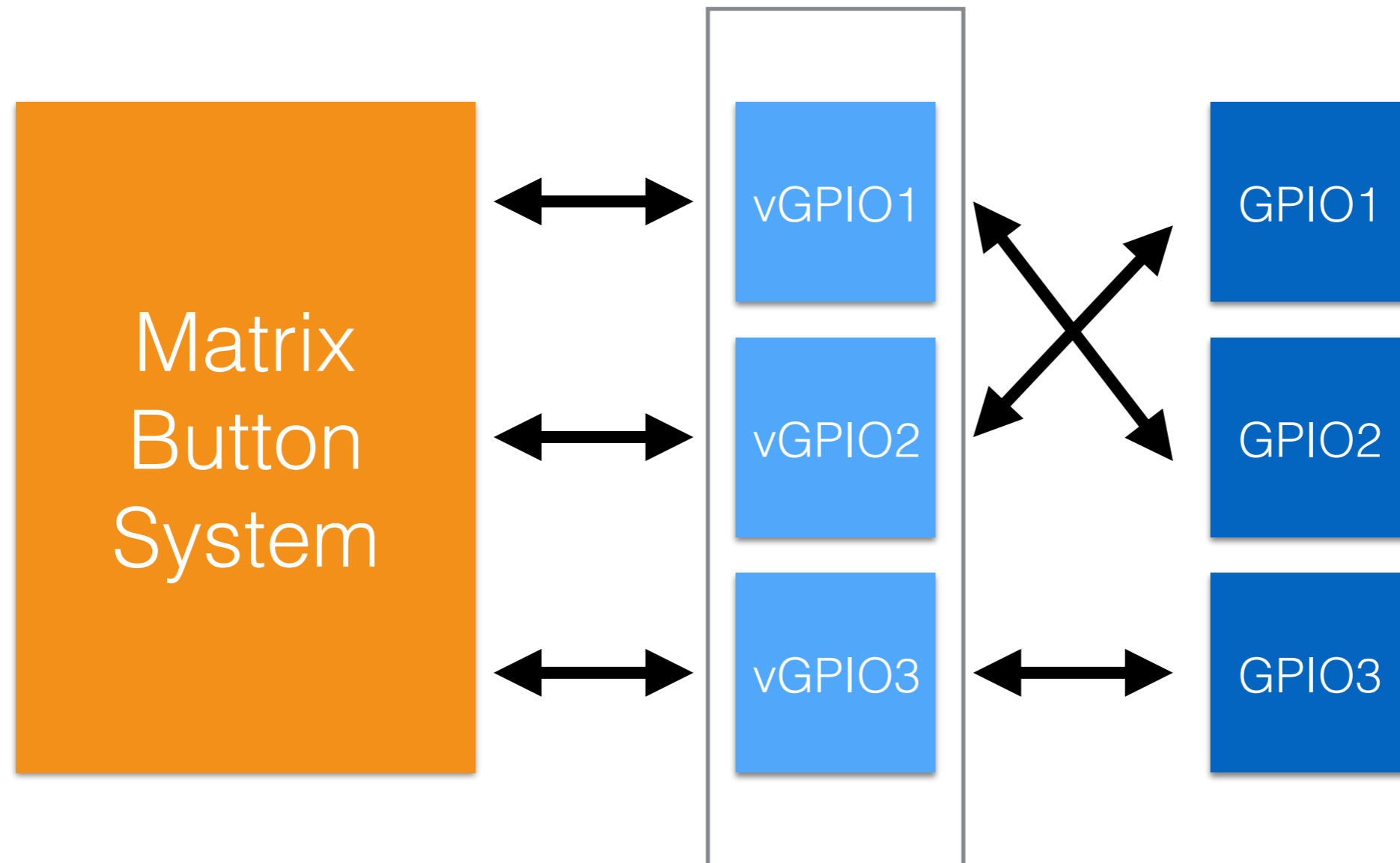
Maintenance

- X11 via SSH
- basically unnecessary
- runs since October
- daily use

Beaglebone Black

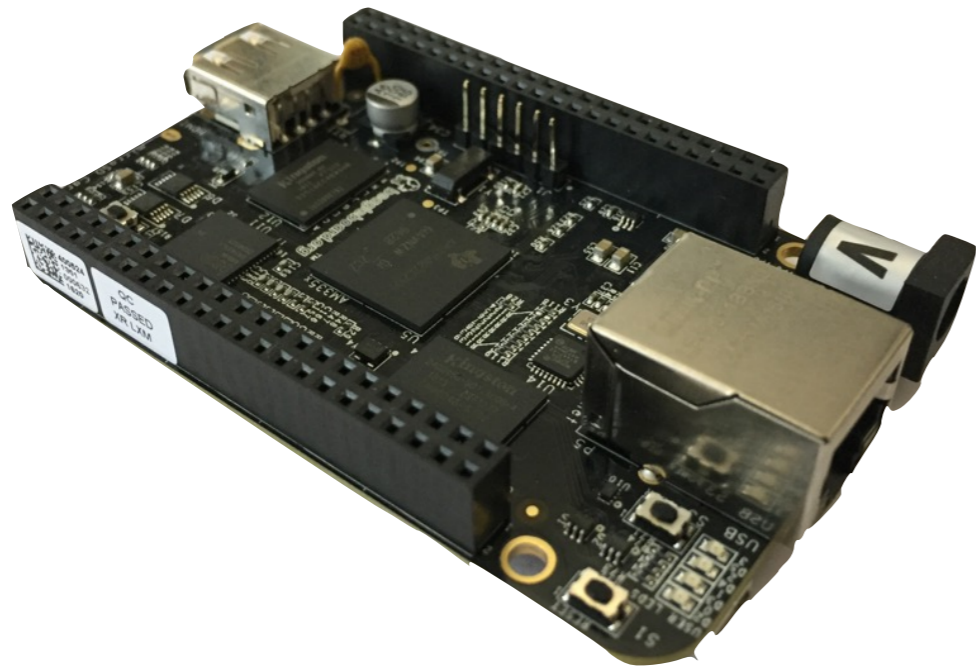


Virtualization Layer



Availability

- 32bit Linux ARM VM
 - available since August 19th, 2016
 - through Cincom Smalltalk Developer Program
- Smalltalk GPIO Access
 - to be determined



Summary

Connecting Hardware to Smalltalk was never more fun