



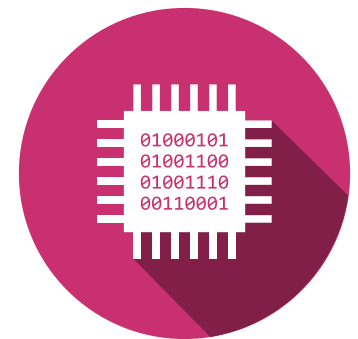
Digitales Design (DiD)

Festwertspeicher

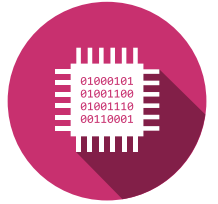
ROM

Studiengang Systemtechnik
Studiengang Energie und Umwelttechnik
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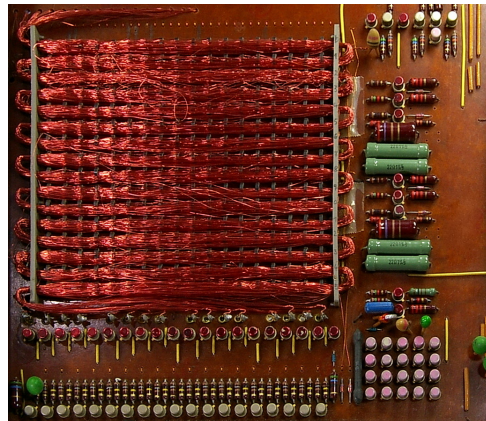
ROM – Read only memory



Festwertspeicher (ROM) ist ein Datenspeicher auf den nur lesend zugegriffen werden kann und der nicht flüchtig ist. Das heisst er hält die Daten auch im stromlosen Zustand.

Wird heutzutage meist durch Flash ersetzt.

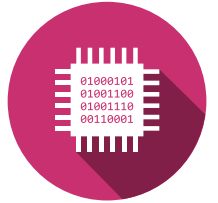
Hauptanwendungsbereich sind die Bios Speicher



Quelle: Wikipedia

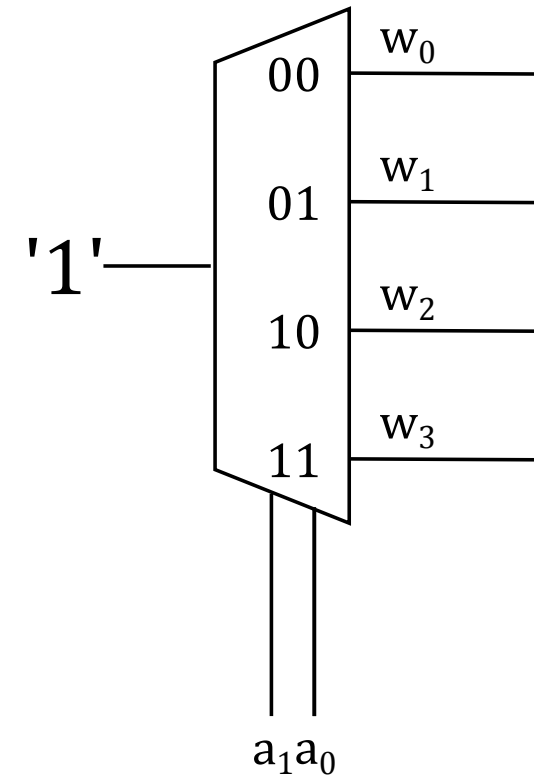
ROM – Read only memory

Mux Aufbau



a_1	a_0	w_0	w_1	w_2	w_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

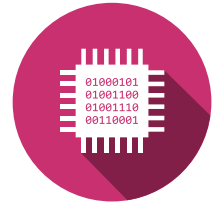
- n -Bit Steuerungseingang
- $2^n n$ -Bit mögliche Ausgänge



Aufgabe

Realisierung einer programmierbaren OR-Funktion

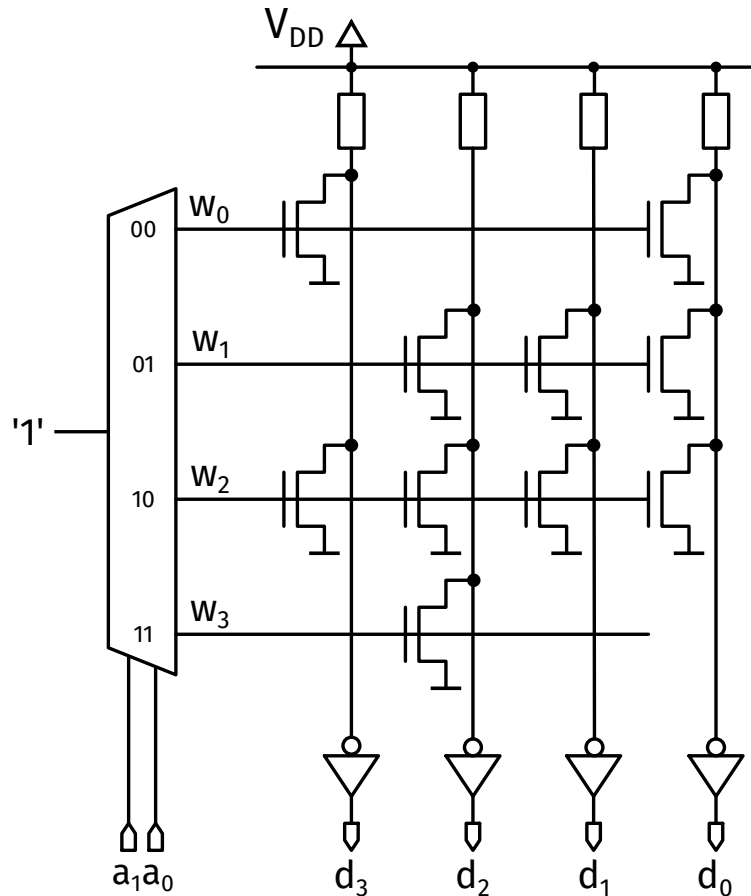
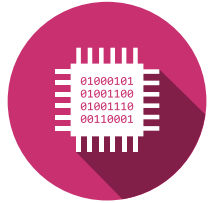
a_1	a_0	w_0	w_1	w_2	w_3	d_3	d_2	d_1	d_0
0	0	1	0	0	0	1	0	0	1
0	1	0	1	0	0	0	1	1	1
1	0	0	0	1	0	1	1	1	1
1	1	0	0	0	1	0	1	0	0



$$\begin{cases} d_3 = \overline{a_0} \\ d_2 = a_0 + a_1 \\ d_1 = a_0 \oplus a_1 \\ d_0 = \overline{a_0 * a_1} \end{cases}$$

ROM – Read only memory

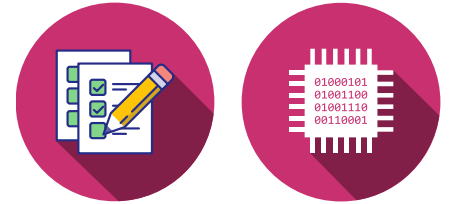
Mux-OR Aufbau & Kapazität



$$C = n_w * n_d = 2^{n_w} * n_d$$

Aufgabe 1.1 (rom/logic-function-01)

Speichergrößen

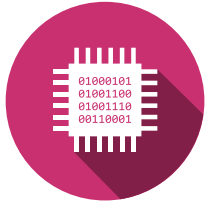


- a) Was für eine Kapazität hat der Speicher im vorherigen Slide?

- b) Was für eine Kapazität besitzt ein Speicher mit 10 Eingangs- und 8 Ausgangsleitungen?

- c) Was für eine Kapazität besitzt ein Speicher mit 16 Eingangs- und 8 Ausgangsleitungen?

Binärsystem - Auffrischung



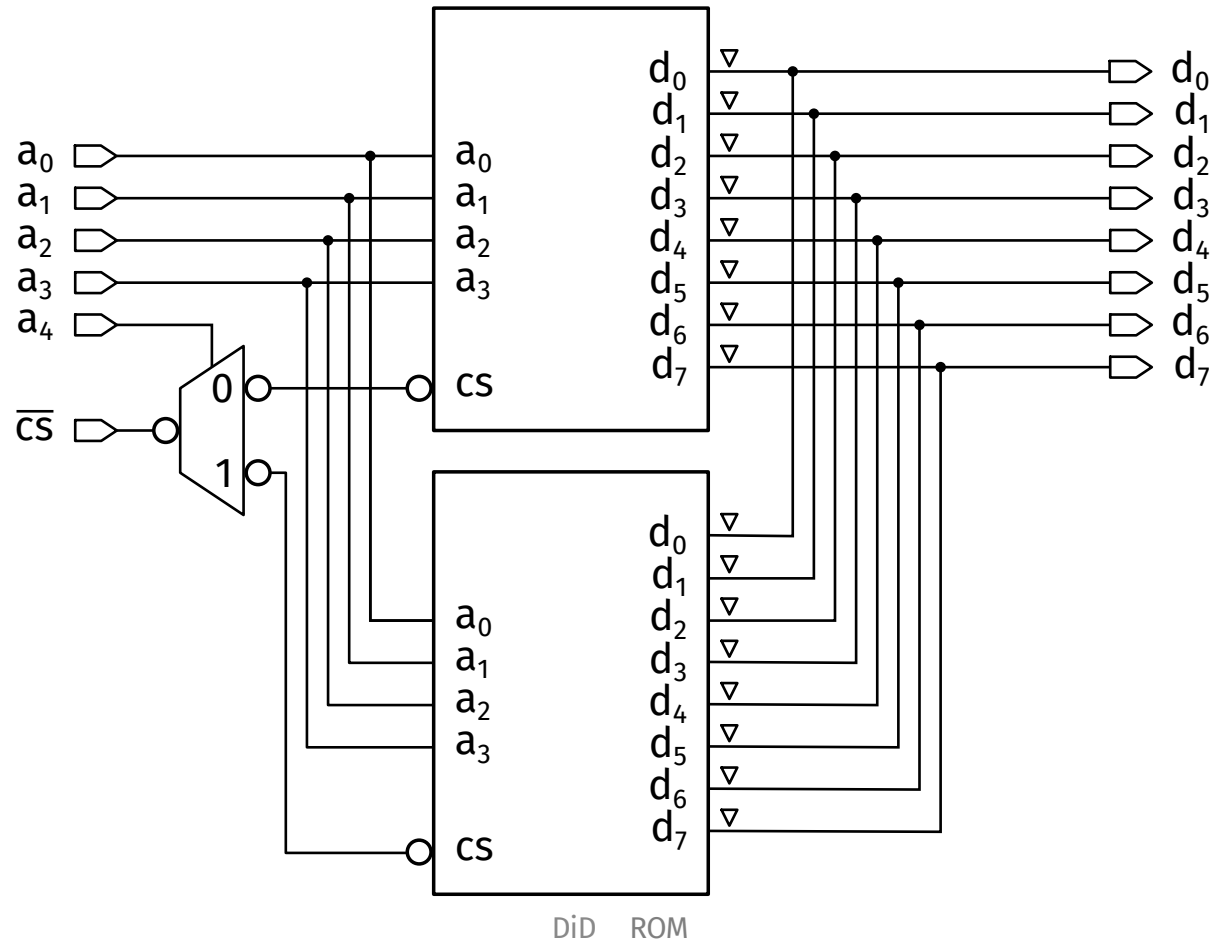
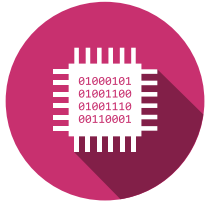
- 8 BIT bilden ein Byte (octet)
 - Rein historisch
- Using IEC standard:
 - 1 KiB = 1'024 bytes (Note: big K)
 - 1 MiB = 1'024 KiB = 1'048'576 bytes
 - 1 GiB = 1'024 MiB = 1'048'576 KiB = 1'073'741'824 bytes
- Using SI standard:
 - 1 kB = 1'000 bytes (Note: small k)
 - 1 MB = 1'000 kB = 1,000,000 bytes
 - 1 GB = 1'000 MB = 1'000'000 KB = 1'000'000'000 bytes

11110101

8 Bit = 1 Byte

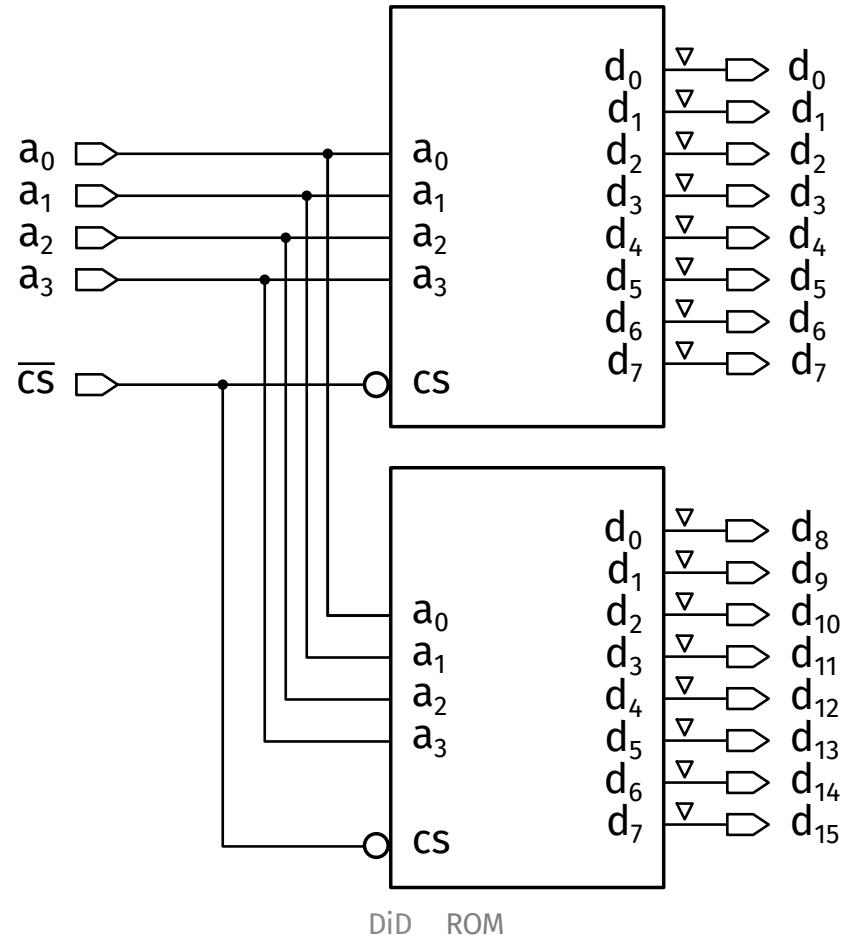
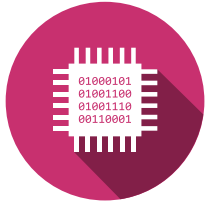
Speicher Zusammenschaltung

Serienschaltung



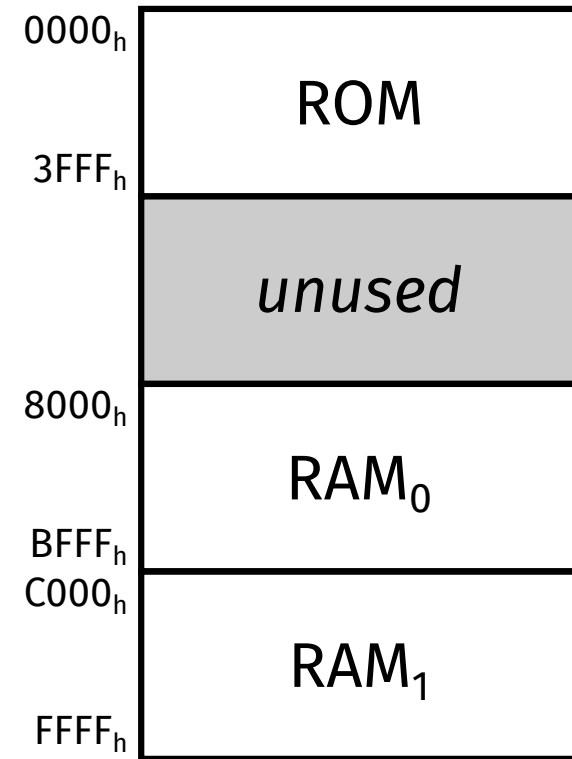
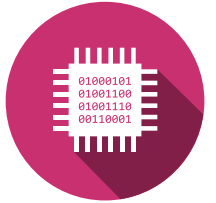
Speicher Zusammenschaltung

Parallelschaltung



Speicherbelegungsplan

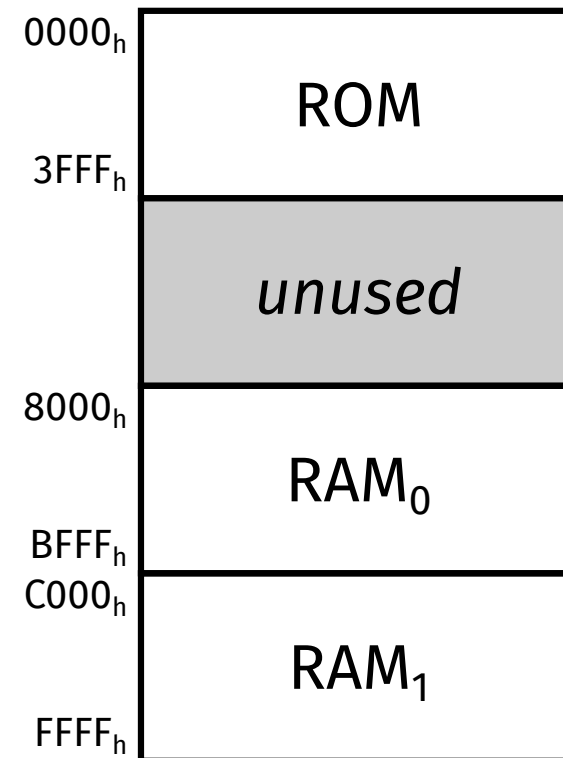
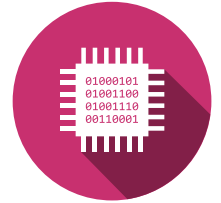
- Speicherbelegungsplan eines μP mit 16 Addressleitungen



Aufgabe 2.1 (rom/rom-circuits-01)

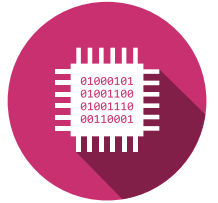
ROM Dekodierung

Zeichnen Sie Dekodierung des ROM der folgenden Speicherbelegung.



Object file format

Intel HEX



- : - Start delimiter
- Byte Count
- Address
- Record Type
 - 00 - Data
 - 01 - End of File
 - 02 - Extended Segment Address
 - 03 - Start Segment Address
 - 04 - Extended Linear Address
 - 05 - Start Linear Address
- Data
- Checksum
 - Das Prüfsummenbyte eines Datensatzes ist das Zweierkomplement des niedrigstwertigen Bytes (LSB) der Summe aller dekodierten Bytewerte im Datensatz vor der Prüfsumme

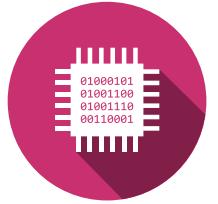
```
:0200000020000FC
:10000000000D1925313C47515B636A71767A7E7F1A
:100010007F7F7E7A76716A635B51473C3125190D8B
:100020000F3E7DBCFC4B9AFA59D968F8A868281A6
:10003000808182868A8F969DA5AFB9C4CFDBE7F316
:00000001FF
```

Aufgabe 3.1.a (rom/crc-01)

CRC Checksum

Berechne die CRC Checksumme des Intel Hex File Eintrages

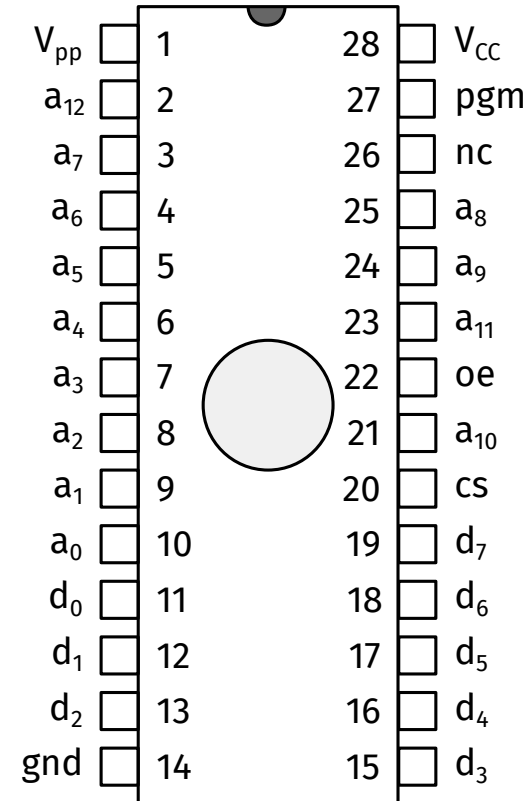
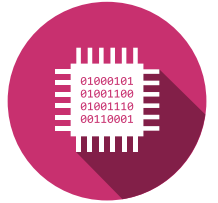
:0300300002337AXX



Speicher

Typen

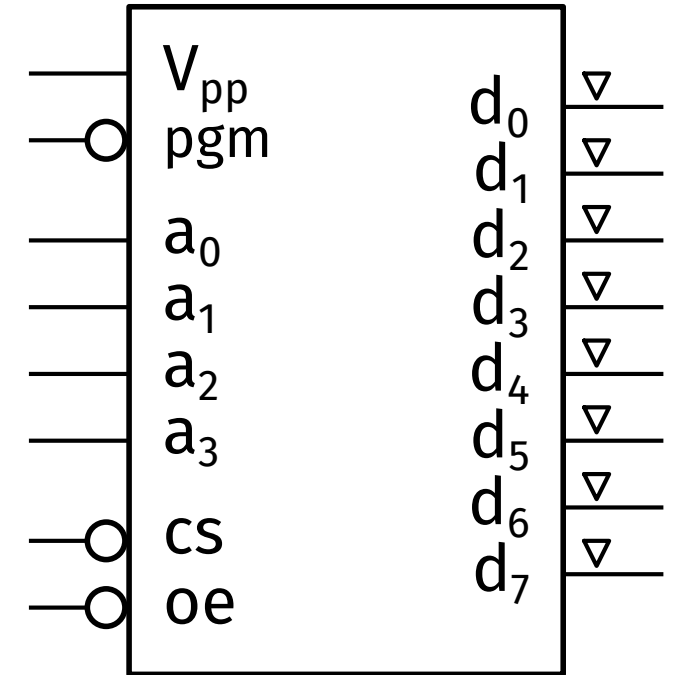
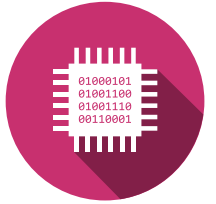
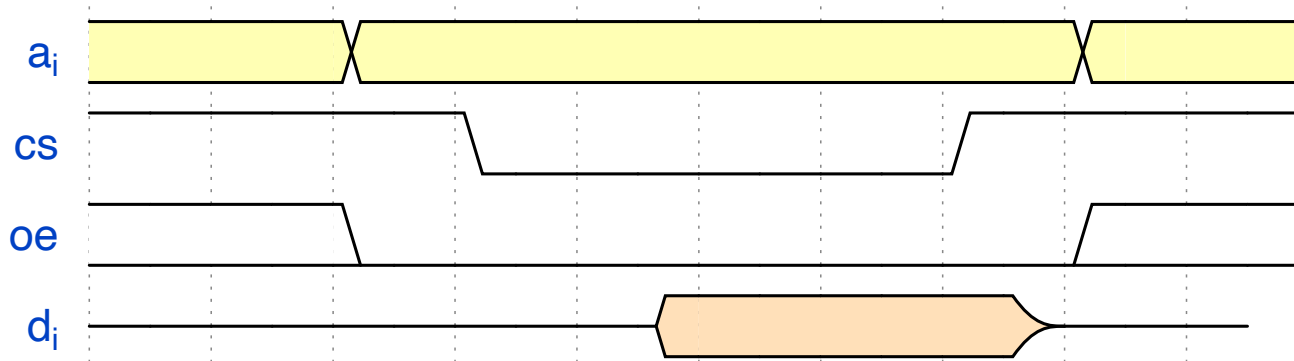
- PROM
- EPROM
- OTP-ROM
- EEPROM
- Flash



Speicherzugriff

Parallele Schnittstelle

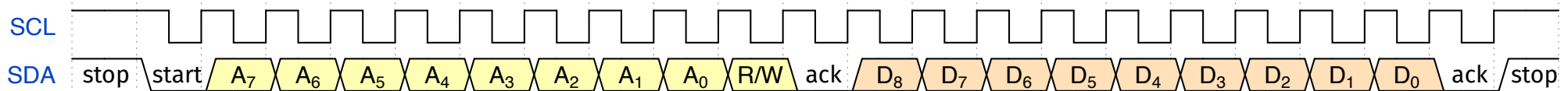
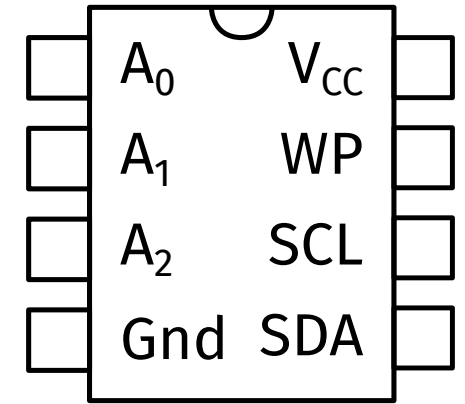
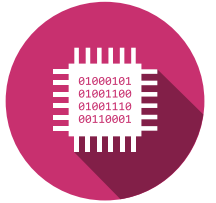
- Mehr Signale
- Höhere Bandbreite
(bei gleichbleibender Taktrate)



Speicherzugriff

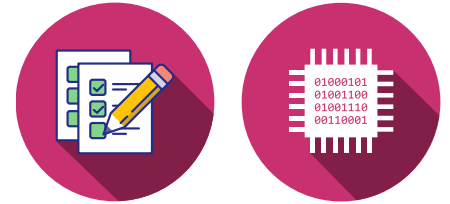
Serieller Schnittstelle (I2C)

- Weniger Signale
 - Tiefere Bandbreite
- (bei gleichbleibender Taktrate)



Aufgabe 4.1 (rom/rom-types-01)

ROM Bandbreite



Eine ROM wird mit serieller (I2C) und paralleler Schnittstelle angeboten. Der Speicher umfasst 8 Adress- und 8 Datenbits und wird mit 66MHz getaktet. Berechnen Sie die theoretische maximale Schreibrate. Ausserdem berechnen Sie um wieviel % der schnellere schneller ist.

WHY ARE THERE MIRRORS ABOVE BEDS

WHY DO I SAY UH

WHY IS SEA SALT BETTER

WHY ARE THERE TREES IN THE MIDDLE OF FIELDS

WHY IS THERE NOT A POKEMON MMO

WHY IS THERE LAUGHING IN TV SHOWS

WHY ARE THERE DOORS ON THE FREEWAY

WHY ARE THERE SO MANY SUCHOST.EXE RUNNING

WHY AREN'T ANY COUNTRIES IN ANTARCTICA

WHY ARE THERE SCARY SOUNDS IN MINECRAFT

WHY IS THERE KICKING IN MY STOMACH

WHY ARE THERE TWO SLASHES AFTER HTTP

WHY ARE THERE CELEBRITIES

WHY DO SNAKES EXIST

WHY DO OYSTERS HAVE PEARLS

WHY ARE DUCKS CALLED DUCKS

WHY DO THEY CALL IT THE CLAP

WHY ARE KYLE AND CARTMAN FRIENDS

WHY IS THERE AN ARROW ON AANG'S HEAD

WHY ARE TEXT MESSAGES BLUE

WHY ARE THERE MUSTACHES ON CLOTHES

WHY WUBA LUBBA DUB DUB MEANING

WHY IS THERE A WHALE AND A POT FALLING

WHY ARE THERE SO MANY BIRDS IN SWISS

WHY IS THERE SO LITTLE RAIN IN WALLIS

WHY IS WALLIS WEATHER FORECAST ALWAYS WRONG

WHY ARE THERE MALE AND FEMALE BIKES

WHY ARE THERE BRIDESMAIDS

WHY DO DYING PEOPLE REACH UP

HOW FAST IS LIGHTSPEED

WHY ARE OLD KLINGONS DIFFERENT

WHY ARE THERE

SQUIRRELS



WHY AREN'T THERE DINOSAURS ABOVE BEDS

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WHY DO DYING PEOPLE REACH UP

HOW FAST IS LIGHTSPEED

WHY ARE OLD KLINGONS DIFFERENT

WHY ARE THERE

SQUIRRELS



WHY IS THERE CAFFEINE IN MY SHAMPOO

WHY HAVE DINOSAURS NO FUR

WHY DO IGUANAS DIE

WHY AREN'T THERE DINOSAURS ABOVE BEDS

WHY DO I SAY UH

WHY IS SEA SALT BETTER

WHY ARE THERE TREES IN THE MIDDLE OF FIELDS

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HOW FAST IS LIGHTSPEED

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WHY ARE THERE

SQUIRRELS

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WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

WHY IS THERE NO GPS IN LAPTOPS

WHY DO KNEES CLICK

WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

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WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

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WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

QUESTIONS

CAN BE ASKED BY ANYONE ANYTIME

WHY AREN'T ECONOMISTS RICH

WHY DO AMERICANS CALL IT SOCCER

WHY ARE MY EARS RINGING

WHY IS 42 THE ANSWER TO EVERYTHING

WHY CAN'T NOBODY ELSE LIFT THORS HAMMER

WHY IS MARVIN ALWAYS SO SAD

WHY ARE THERE ANTS IN MY LAPTOP

WHY IS EARTH TILTED

WHY IS SPACE BLACK

WHY IS OUTER SPACE SO COLD

WHY ARE THERE PYRAMIDS ON THE MOON

WHY IS NASA SHUTTING DOWN

WHY ARE THERE

GHOSTS

WHY ARE THERE AN OWL IN MY BACKYARD

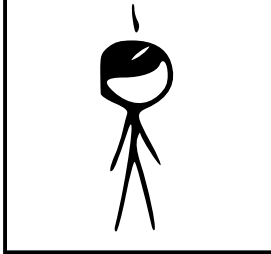
WHY IS THERE AN OWL OUTSIDE MY WINDOW

WHY IS THERE AN OWL ON THE DOLLAR BILL

WHY DO OWLS ATTACK PEOPLE

WHY ARE FPGA's EVERYWHERE

WHY ARE THERE



WHAT IS <https://xkcd.com/1256/>

WHY DO THEY SAY T-MINUS

WHY ARE THERE OBELISKS

WHY ARE WRESTLERS ALWAYS WET

WHY ARE THERE TWO SPOCKS

WHY IS THERE A LINE THROUGH HTTPS

WHY IS THERE A RED LINE THROUGH HTTPS ON TWITTER

WHY IS HTTPS IMPORTANT



WHY ARE THERE SO MANY CROWS IN ROCHESTER

WHY IS TO BE OR NOT TO BE FUNNY

WHY DO CHILDREN GET CANCER

WHY IS POSEIDON ANGRY WITH ODYSSEUS

WHY IS THERE ICE IN SPACE

WHY ARE THERE AN OWL IN MY BACKYARD

WHY IS THERE AN OWL OUTSIDE MY WINDOW

WHY IS THERE AN OWL ON THE DOLLAR BILL

WHY DO OWLS ATTACK PEOPLE

WHY ARE FPGA's EVERYWHERE

WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE

WHY ARE THERE GODS

WHY ARE THERE TWO SPOCKS

WHY ARE MY BOOBS ITCHY

WHY ARE CIGARETTES LEGAL

WHY ARE THERE DUCKS IN MY POOL

WHY IS JESUS WHITE

WHY IS THERE LIQUID IN MY EAR

WHY DO Q TIPS FEEL GOOD

WHY DO PEOPLE DIE

WHY AREN'T MY

ARMS GROWING

WHY AREN'T THERE GUNS IN

WHY ARE THERE WEEKS

WHY DO I FEEL DIZZY

WHY ARE THERE DOGS AFRAID OF FIRE

WHY IS THERE NO KING IN EN

WHY ARE THERE DOGS AFRAID OF FIRE

WHY IS THERE NO KING IN EN

WHY ARE THERE DOGS AFRAID OF FIRE

WHY IS THERE NO KING IN EN

WHY ARE THERE DOGS AFRAID OF FIRE

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WHY IS THERE NO KING IN EN

WHY ARE THERE DOGS AFRAID OF FIRE

WHY IS THERE NO KING IN EN



Hes·so  **VALAIS
WALLIS**



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Hochschule für Ingenieurwissenschaften

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