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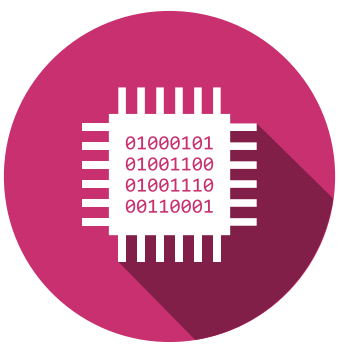
Digitales Design (DiD)

Synchrone Zähler

CNT

Studiengang Systemtechnik
Studiengang Energie und Umwelttechnik
Studiengang Informatik und Kommunikationssysteme



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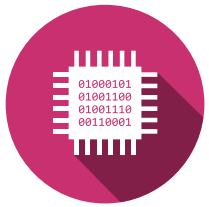
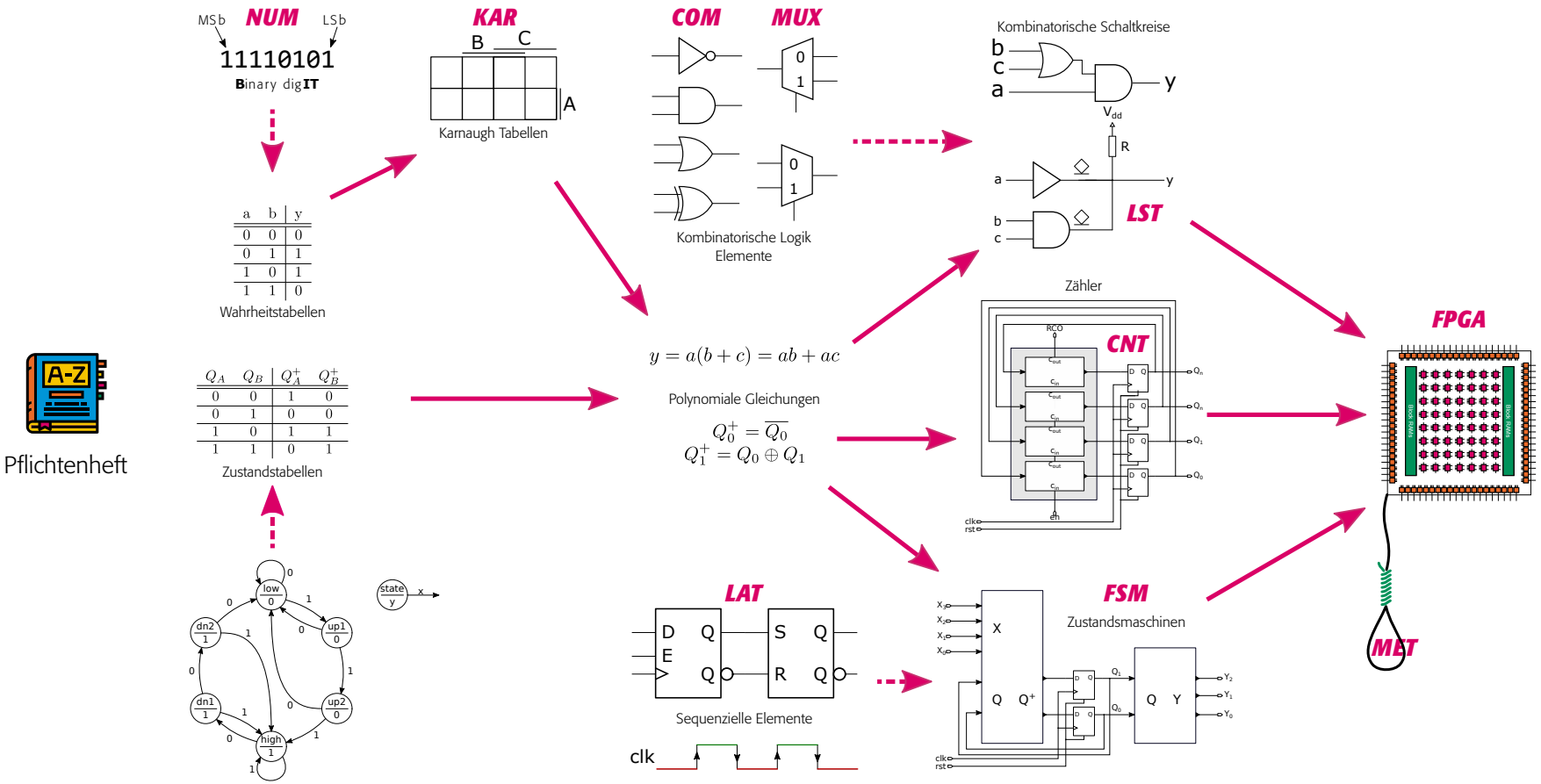
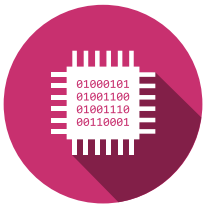
Aktueller Inhalt des Themas im Kurs





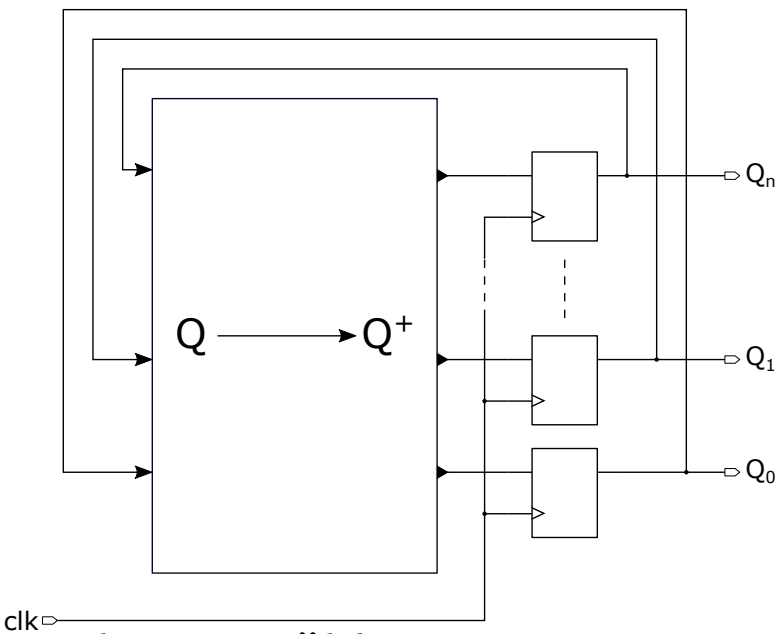
Inhalt

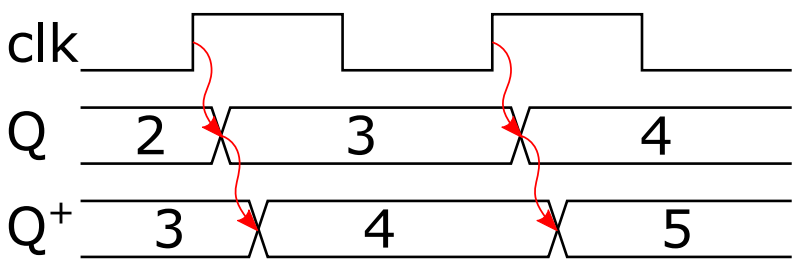


- **Aufbau der Synchronzähler**
- Zähler mit Zweierpotenz
- Zähler mit ungeordneter Sequenz
- Iterative Schaltkreise

Synchronzähler

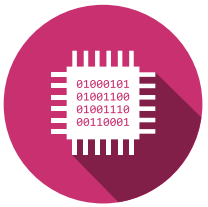
Architektur





- Synchroner Zähler:
- Eine Logikschaltung berechnet den nachfolgenden Wert
- Dieser Wert wird beim nächsten Taktschlag in die Flip-Flops geladen.
- Die Logikschaltung berechnet erneut den nachfolgenden Wert

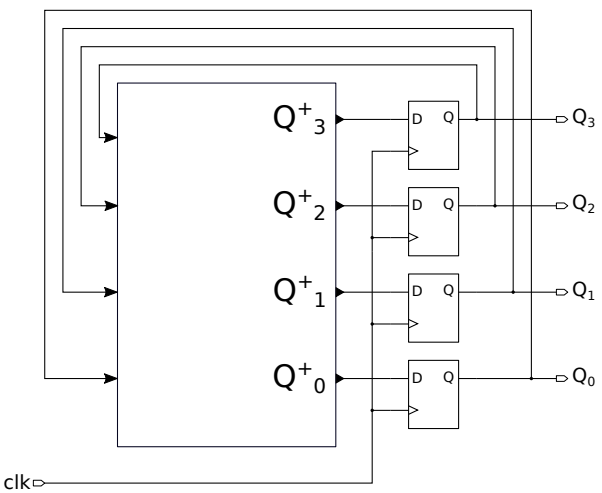
Inhalt



- Aufbau der Synchronzähler
- **Zähler mit Zweierpotenz**
  - Mit D-FlipFlops
  - Mit anderen FlipFlop Typen
- Zähler mit ungeordneter Sequenz
- Iterative Schaltkreise

Synchronzähler

Zähler auf 16 (2^4) mit D-FlipFlops

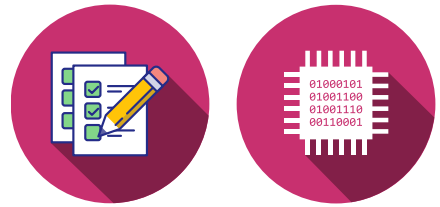


$$D_0 = Q_0^+ \quad D_0 = Q_0 \oplus 1 \quad D_0 = \overline{Q_0}$$
$$D_1 = Q_1^+ \quad D_1 = Q_1 \oplus Q_0$$
$$D_2 = Q_2^+ \quad D_2 = Q_2 \oplus Q_1 Q_0$$
$$D_3 = Q_3^+ \quad D_3 = Q_3 \oplus Q_2 Q_1 Q_0$$

Q_3	Q_2	Q_1	Q_0	$Q+_3$	$Q+_2$	$Q+_1$	$Q+_0$
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	1	1
1	0	1	1	1	1	0	0
1	1	0	0	1	1	0	1
1	1	0	1	1	1	1	0
1	1	1	0	1	1	1	1
1	1	1	1	0	0	0	0

Aufgabe 1.1 *(cnt/pow2-01)*

Abwärtszähler



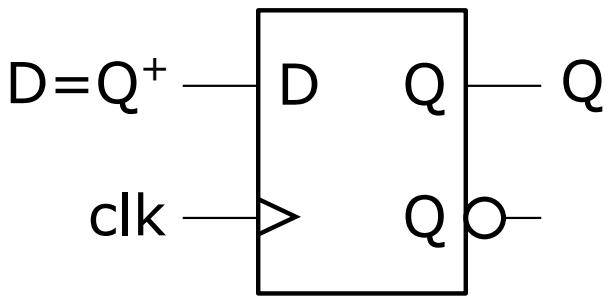
Erstellen Sie mit Hilfe von D-Flipflops und von kombinatorischen Logikgattern einen synchronen Abwärtszähler mit der Sequenz:

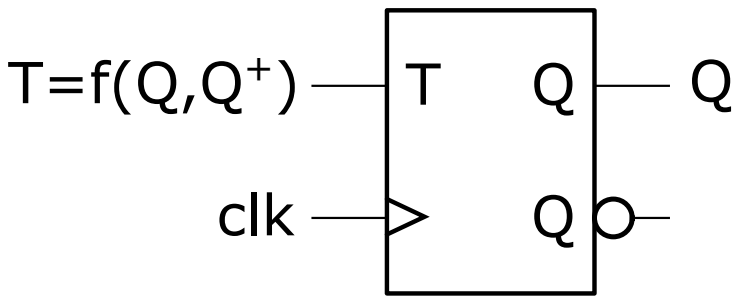
15 – 14 – 13 – 12 - … - 3 – 2 – 1- 0 – 15 - …

Zeichnen Sie das vollständige Schema

Synchronzähler

Zähler anderen FlipFlop Typen





Q	Q⁺	D	T	E	D
0	0	0	0	0 1	- 0
0	1	1	1	1	1
1	0	0	1	1	0
1	1	1	0	0 1	- 1

Synchronzähler

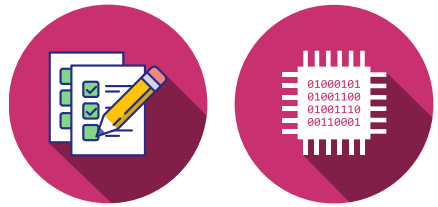
Zähler mit T-FlipFlops

Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+	T_3	T_2	T_1	T_0
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	1
0	0	1	0	0	0	1	1	0	0	0	1
0	0	1	1	0	1	0	0	0	1	1	1
0	1	0	0	0	1	0	1	0	0	0	1
0	1	0	1	0	1	1	0	0	0	1	1
0	1	1	0	0	1	1	1	0	0	0	1
0	1	1	1	1	0	0	0	1	1	1	1
1	0	0	0	1	0	0	1	0	0	0	1
1	0	0	1	1	0	1	0	0	0	1	1
1	0	1	0	1	0	1	1	0	0	0	1
1	0	1	1	1	1	0	0	0	1	1	1
1	1	0	0	1	1	0	1	0	0	0	1
1	1	0	1	1	1	1	0	0	0	1	1
1	1	1	0	1	1	1	1	0	0	0	1
1	1	1	1	0	0	0	0	1	1	1	1

$$T_0 = 1$$
$$T_1 = Q_0$$
$$T_2 = Q_1 Q_0$$
$$T_3 = Q_2 Q_1 Q_0$$

Aufgabe 1.2 *(cnt/pow2-02)*

Abwärtszähler

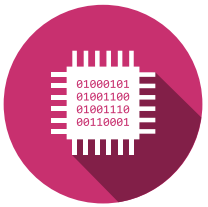


Erstellen Sie mit Hilfe von T-Flipflops und von NAND-Gattern einen synchronen Abwärtszähler mit der Sequenz:

7 – 6 - … - 3 – 2 – 1- 0 – 7 - …

Zeichnen Sie das vollständige Schema

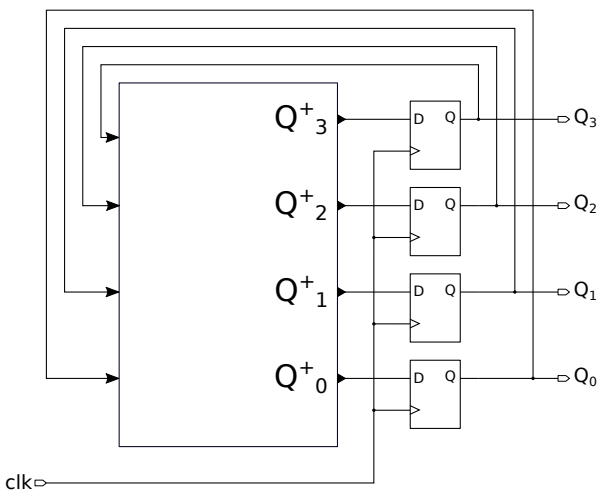
Inhalt



- Aufbau der Synchronzähler
- Zähler mit Zweierpotenz
- **Zähler mit ungeordneter Sequenz**
  - Realisierung
  - Verifikation
- Iterative Schaltkreise

Synchronzähler

Realisierung einers Modulo 10 Zählers

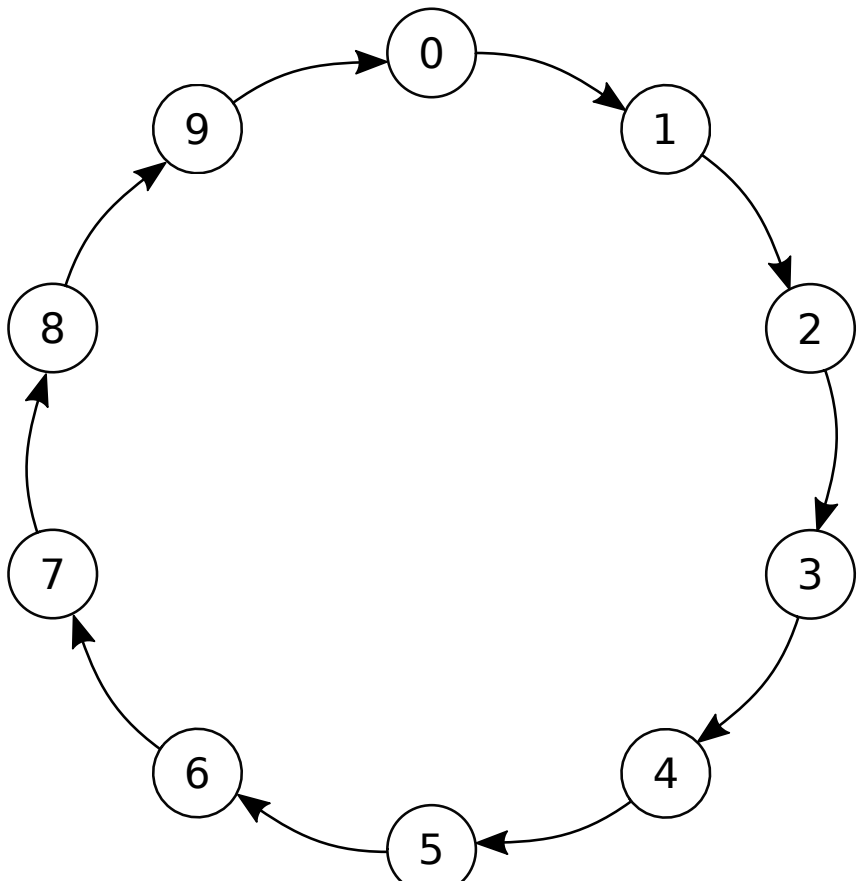


$$D_0 = \overline{Q_0}$$
$$D_1 = Q_1\overline{Q_0} + \overline{Q_3}\,\overline{Q_1}Q_0$$
$$D_2 = Q_2\overline{Q_1} + Q_2\overline{Q_0} + \overline{Q_2}Q_1Q_0$$
$$D_3 = Q_3\overline{Q_0} + Q_2Q_1Q_0$$

Q_3	Q_2	Q_1	Q_0	$Q+_3$	$Q+_2$	$Q+_1$	$Q+_0$
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0
1	0	1	0	-	-	-	-
1	0	1	1	-	-	-	-
1	1	0	0	-	-	-	-
1	1	0	1	-	-	-	-
1	1	1	0	-	-	-	-
1	1	1	1	-	-	-	-

Synchronzähler

Verifikation – Zustandsgraph der Zählers



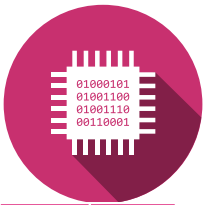
10 11

12 ? 13

14 15

Synchronzähler

Verifikation – Nicht definierte Zustände

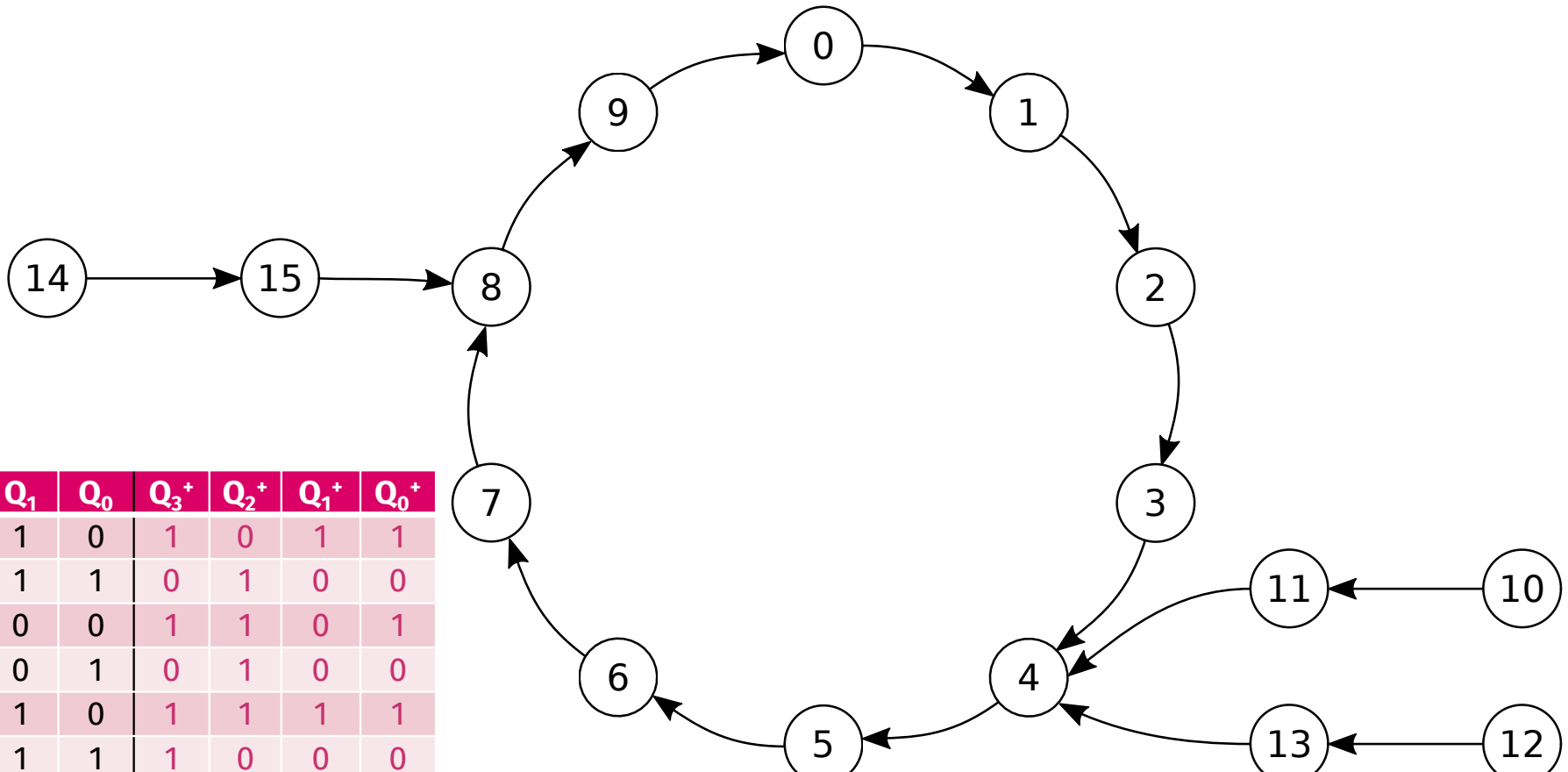


$$D_0 = \overline{Q_0}$$
$$D_1 = Q_1\overline{Q_0} + \overline{Q_3}\,\overline{Q_1}Q_0$$
$$D_2 = Q_2\overline{Q_1} + Q_2\overline{Q_0} + \overline{Q_2}Q_1Q_0$$
$$D_3 = Q_3\overline{Q_0} + Q_2Q_1Q_0$$

Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0
1	0	1	0	1	0	1	1
1	0	1	1	0	1	0	0
1	1	0	0	1	1	0	1
1	1	0	1	0	1	0	0
1	1	1	0	1	1	1	1
1	1	1	1	1	0	0	0

Synchronzähler

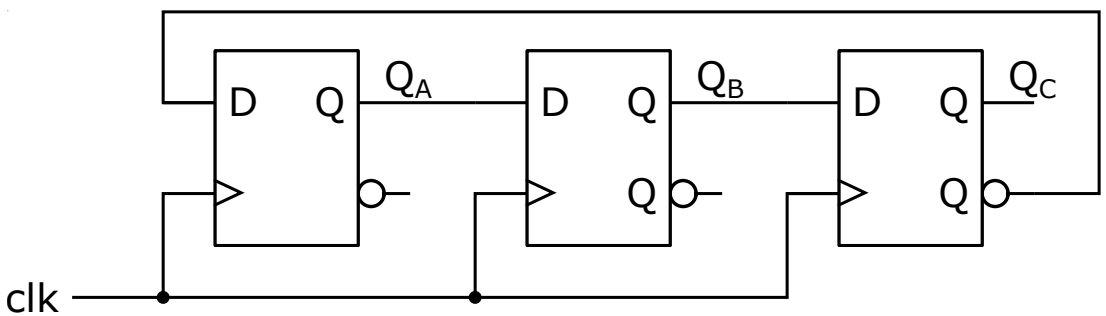
Verifikation – Komplettierter Graph



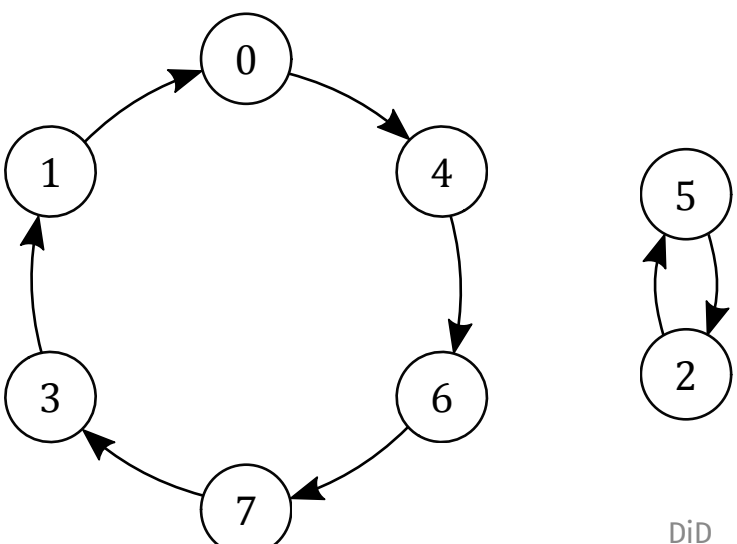
Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+
1	0	1	0	1	0	1	1
1	0	1	1	0	1	0	0
1	1	0	0	1	1	0	1
1	1	0	1	0	1	0	0
1	1	1	0	1	1	1	1
1	1	1	1	1	0	0	0

Synchronzähler

Johnson Zähler



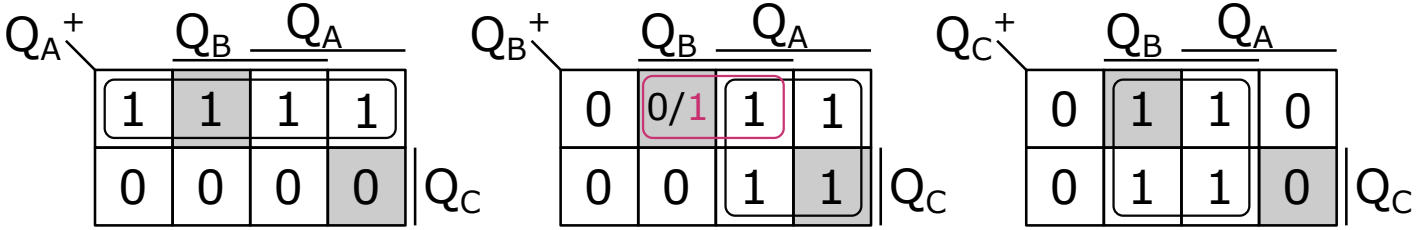
$$D_A = Q_A^+ = \overline{Q_C}$$
$$D_B = Q_B^+ = Q_A$$
$$D_C = Q_C^+ = Q_B$$



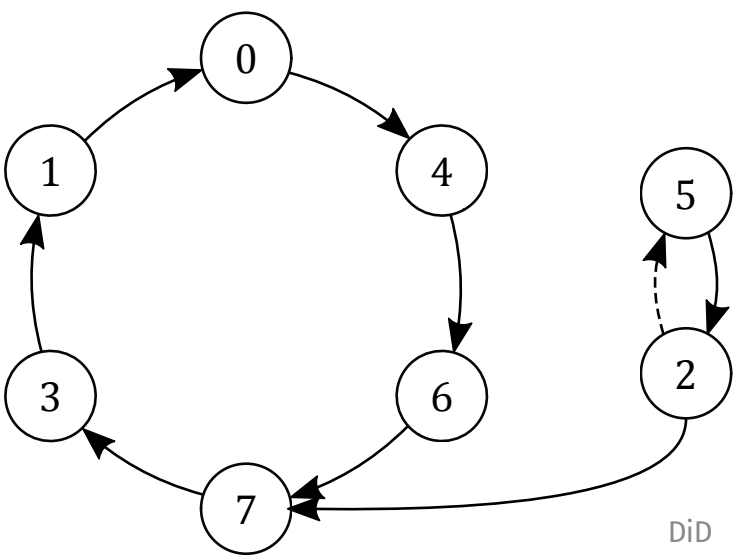
Q_A	Q_B	Q_C	Q_A^+	Q_B^+	Q_C^+
0	0	0	1	0	0
0	0	1	0	0	0
0	1	0	1	0	1
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	0	1	0
1	1	0	1	1	1
1	1	1	0	1	1

Synchronzähler

Johnson Zähler



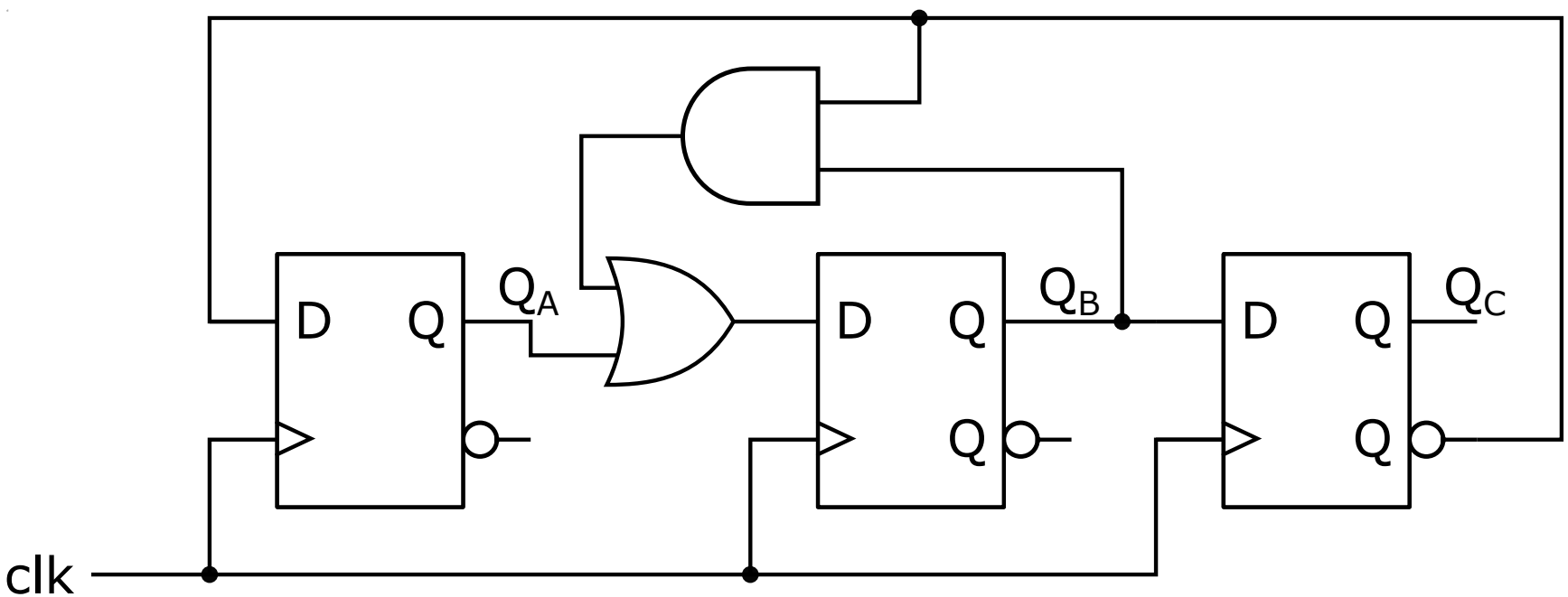
$$D_A = Q_A^+ = \overline{Q_C}$$
$$D_B = Q_B^+ = Q_A + Q_B\overline{Q_C}$$
$$D_C = Q_C^+ = Q_B$$



Q_A	Q_B	Q_C	Q_A^+	Q_B^+	Q_C^+
0	0	0	1	0	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	0	1	0
1	1	0	1	1	1
1	1	1	0	1	1

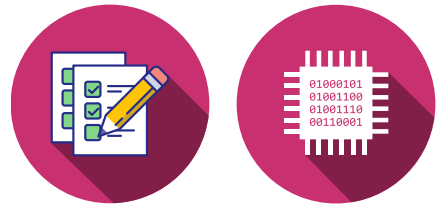
Synchronzähler

Johnson Zähler



Aufgabe 2.1 *(cnt/cnt-01)*

Abwärtszähler



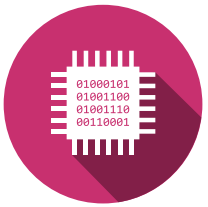
Erstellen Sie mit Hilfe von D-Flipflops und von NAND-Gattern einen Modulo-10 synchronen Abwärtszähler mit der Sequenz:

9 – 8 – 7 - … - 3 – 2 – 1- 0 – 9 - …

Zeichnen Sie das vollständige Schema.

Zeichnen Sie des Zustandsgraph mit allen Zuständen, auch mit denjenigen ausserhalb der Hauptschleife.

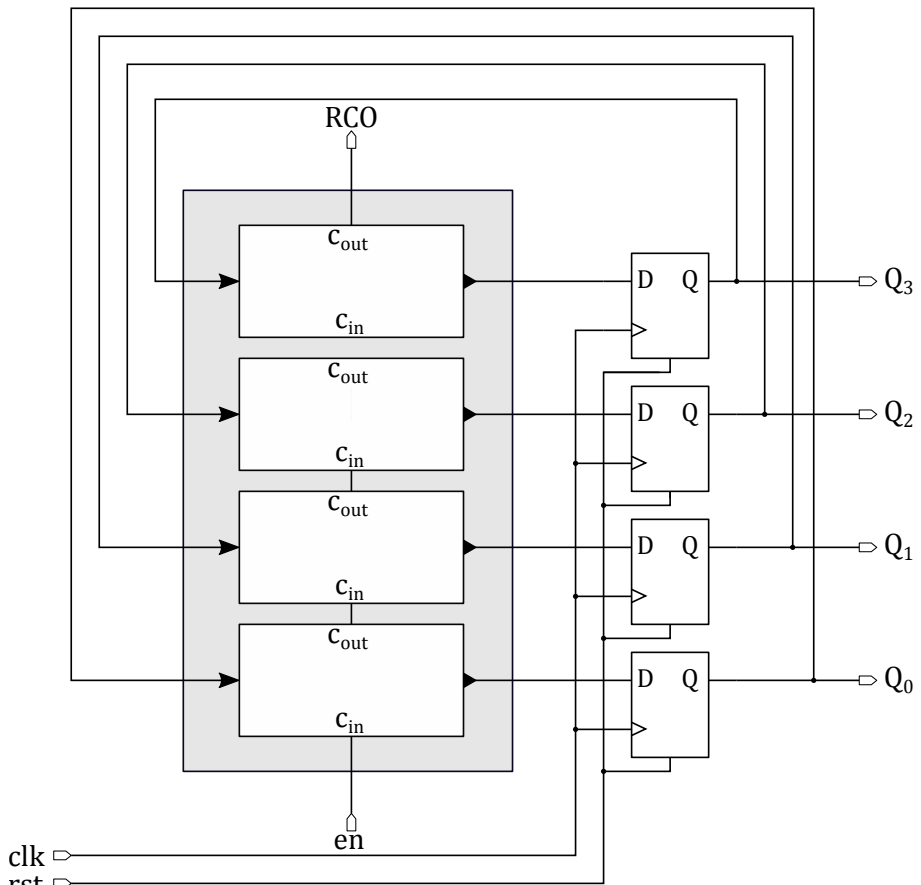
Inhalt



- Aufbau der Synchronzähler
- Zähler mit Zweierpotenz
- Zähler mit ungeordneter Sequenz
- **Iterative Schaltkreise**
  - Iterativer Zähler

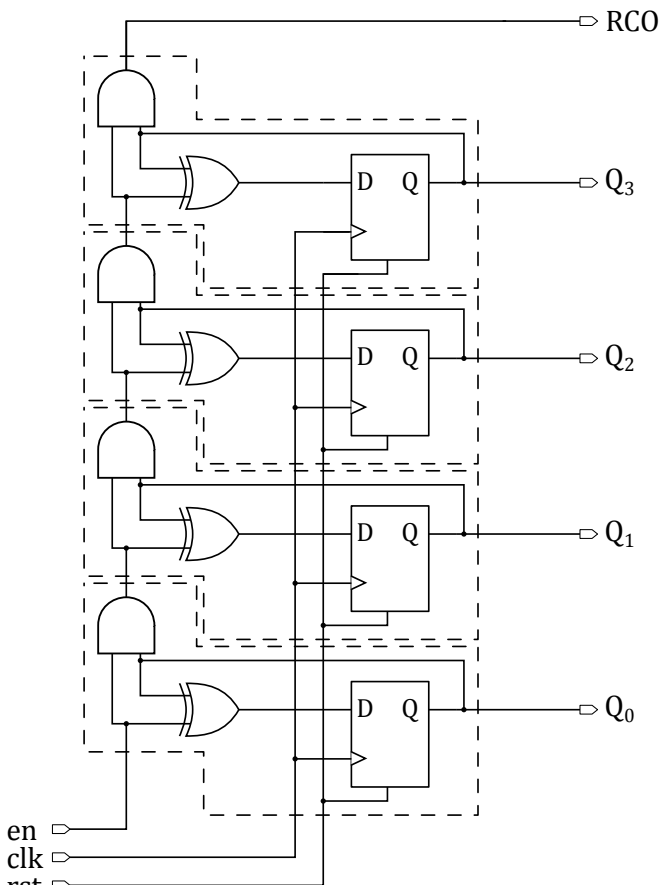
Synchronzähler

Iterativer Zähler - Architektur



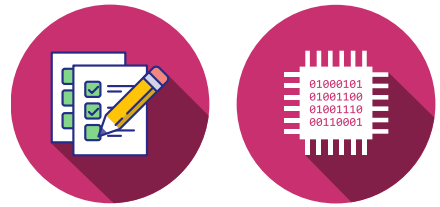
Synchronzähler

Iterativer Zähler - Schaltung



Aufgabe 3.3 *(cnt/cnt-iterative-03)*

Auf- und Abwärtszähler

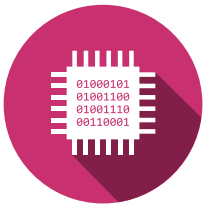


Erstellen Sie einen 4-Bit Aufwärts-Abwärtszähler mit Hilfe von D-Flipflops und von Logikgattern.

Der Aufwärts-Abwärtszähler hat einen Steuereingang up/down.

- Ist up/down = ‘1’, so zählt die Schaltung aufwärts.
- Ist up/down = ‘0’, so zählt die Schaltung abwärts.

Referenzen



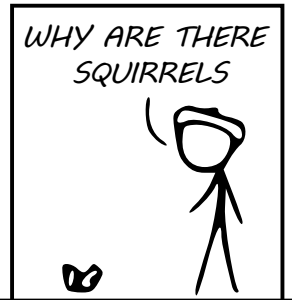
- [Kün97] (Deutsch)
  - Vollständig
  - Elektronikbeispiele
  - Zähler basierend auf Schieberegister
- [Wak00] (Englisch)
  - Iterative Schaltungen, Standard integrierte Schaltungen

- [Man78] (Französisch)
  - Gute Präsentation, korrigierte Übungen

QUESTIONS

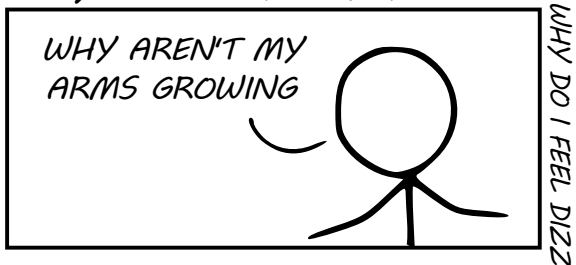
CAN BE ASKED BY ANYONE ANYTIME

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 SVCHOST.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 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 DO IGUANAS DIE
WHY IS THERE CAFFEINE IN MY SHAMPOO
WHY HAVE DINOSAURS NO FUR
WHY ARE SWISS AFRAID OF DRAGONS
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON TWITTER
WHY IS YKK ON ALL ZIPPERS
WHY IS HTTPS IMPORTANT

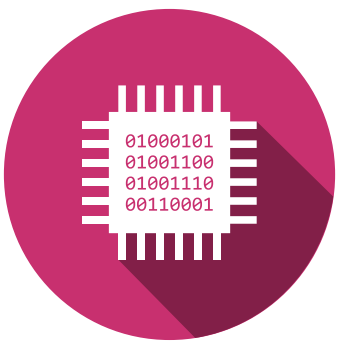


WHY ARE THERE WEEKS
WHY DO I FEEL DIZZY
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY IS 42 THE ANSWER TO EVERYTHING
WHY CAN'T NOBODY ELSE LIFT THORS HAMMER
WHY IS MARVIN ALWAYS SO SAD
WHY IS THERE A SWARM OF ANTS
WHY IS THERE PILEGRIM
WHY IS THERE LAVA
WHY ARE 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 ANTS IN MY LAPTOP
WHY ARE DOGS AFRAID OF FIR
WHY IS THERE NO KING IN EN
WHY IS THERE HELL IF
WHY IS LIFE SO
WHY ARE THERE FEMALE
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 IS 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
WHAT IS https://xkcd.com/1256/
WHY DO THEY SAY T-MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET

Hes·so VALAIS WALLIS

Haute Ecole d'Ingénierie
Hochschule für Ingenieurwissenschaften



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