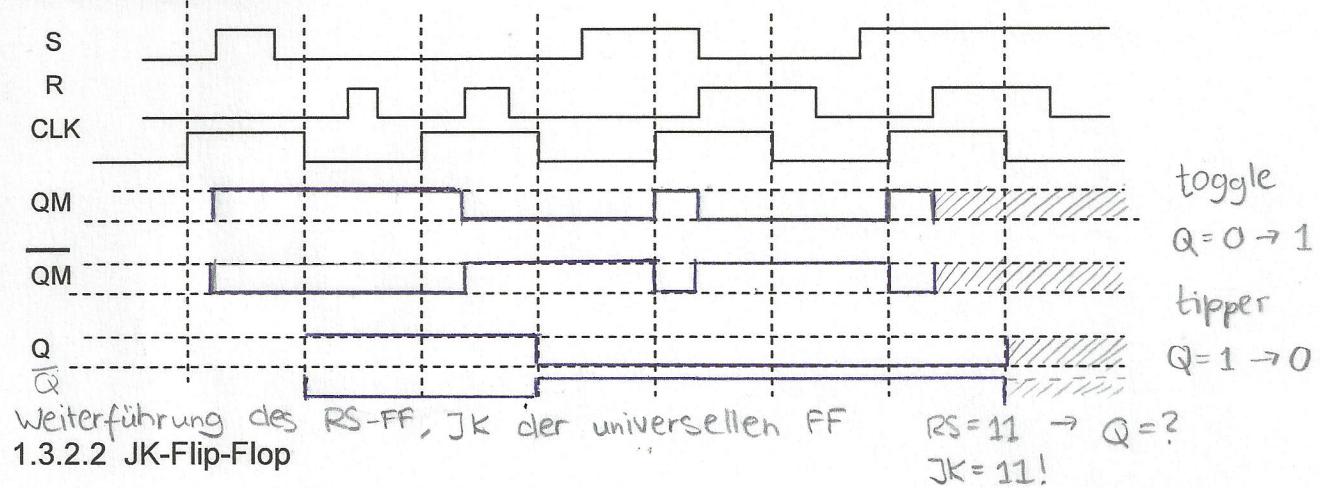
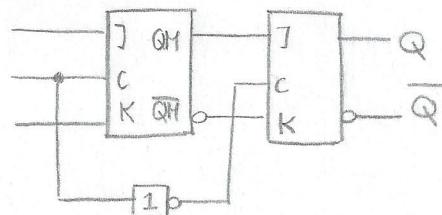


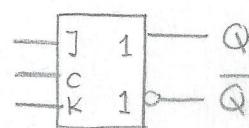
Beispiel Signalverlauf



Blockschaltbild



Symbol



$J = \text{Jump}$
 $K = \text{Kill}$

Zustandsfolgetabelle

J	K	Q	\bar{Q}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

} toggle

Kurzform

J	K	\bar{Q}
0	0	Q
0	1	0
1	0	1
1	1	\bar{Q}

Charakteristische Gleichung

		Q	J	
K		1	1	1
				1

$$\bar{Q} = \bar{J}\bar{Q} + \bar{K}Q$$

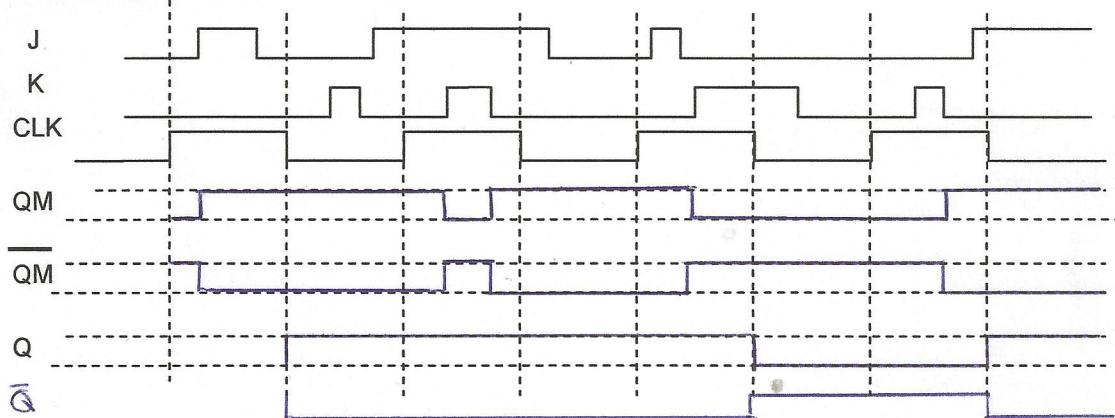
Synthesetabelle

Q	1Q	J	K
0	0	0	0
		0	1
0	1	1	0
		1	1
1	0	0	1
		1	1
1	1	0	0
		1	0

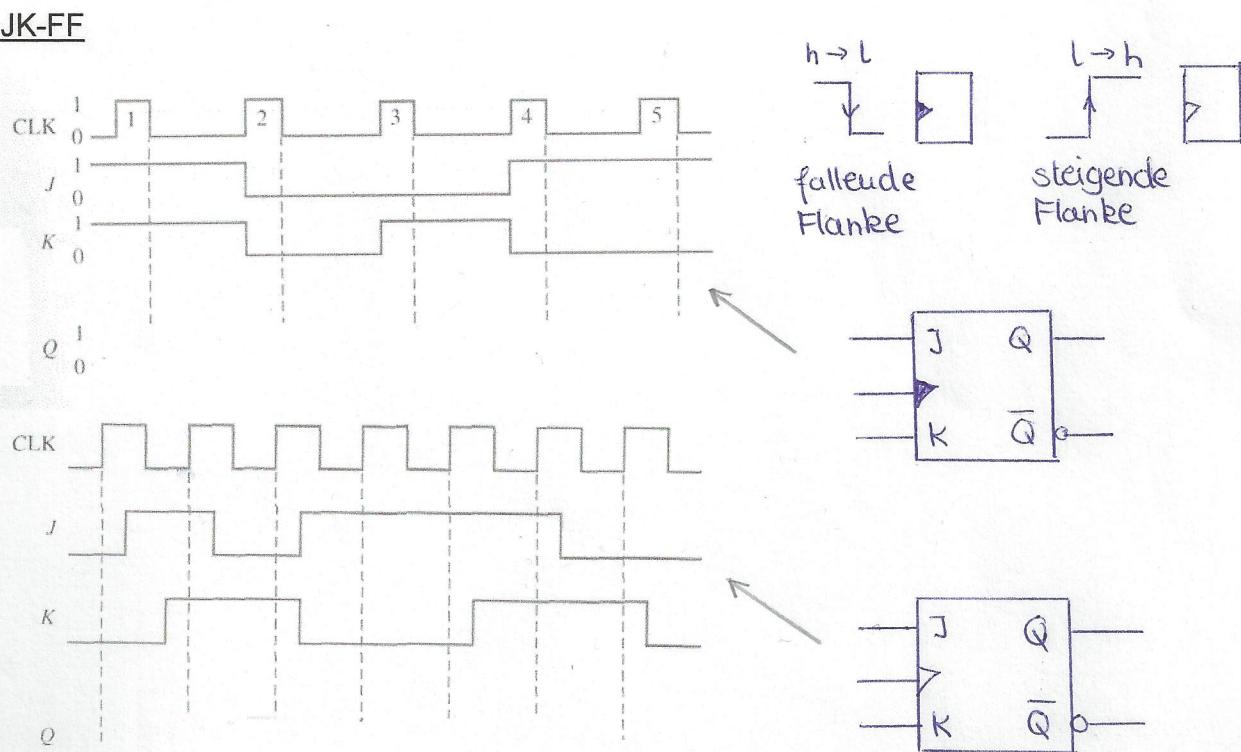
Kurzform

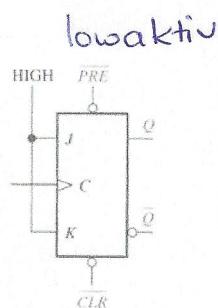
Q	1Q	J	K
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

Beispielsignalverlauf



1.3.3 Taktflankengesteuerte Flip-Flop

JK-FF

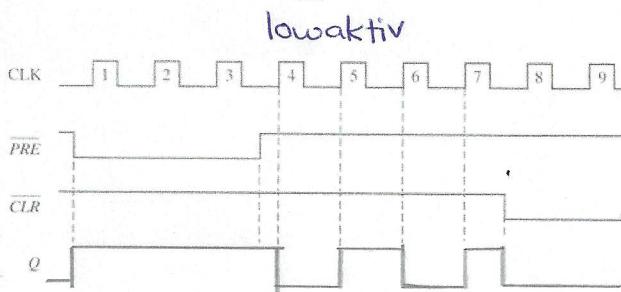


$\overline{\text{PRE}}$ und $\overline{\text{CLR}}$:

spezielle Steuersignale

asynchron

setzen das FF in einen genau definierten Anfangszustand

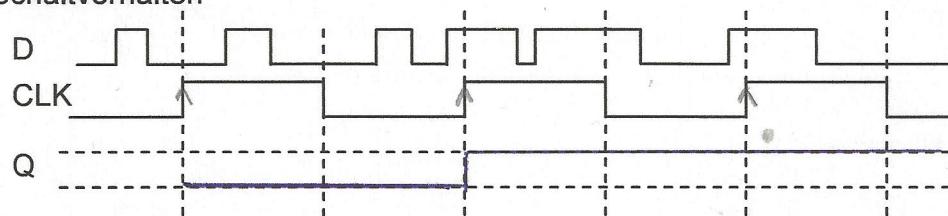


preset: $Q = 1$ clear: $Q = 0$

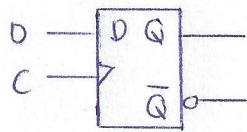
$\overline{\text{PRE}}$	$\overline{\text{CLR}}$	${}^t Q$
L	H	H
H	H	"toggle"
H	L	L

D-FF (Ableitung von flankengesteuerten
D-delay JK-FF)

Schaltverhalten



Symbol



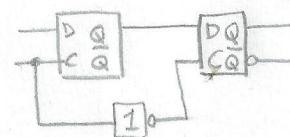
${}^t Q = 0$ wenn C aktiv, ansonsten speichern

Aufgabe 2

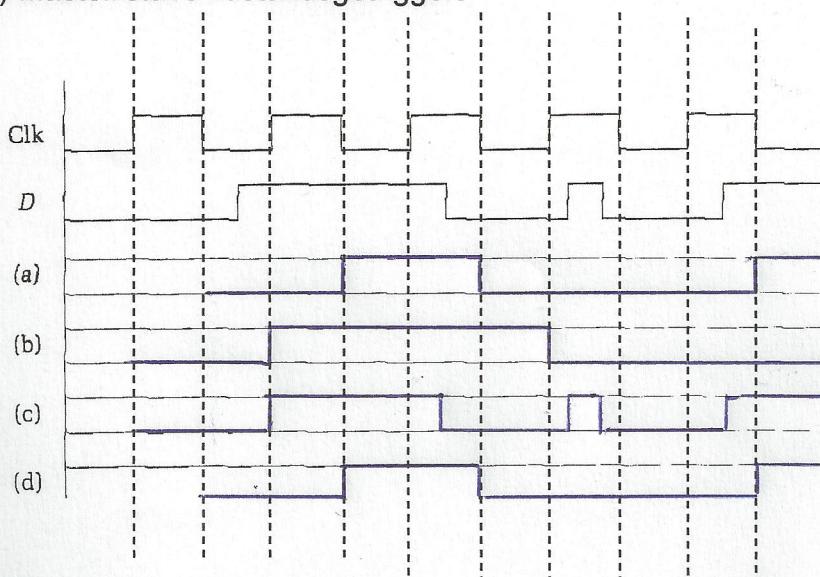
Zeichen Sie den Ausgang Q für folgende D-FF-Typen (Initialzustand Q=0):

- a) negativ flankengetriggert fallende Flanke
- b) positiv flankengetriggert steigende Flanke
- c) zustandsgetriggert +
- d) Master/Slave zustandsgetriggert

d.)



C	D	${}^t Q$
0	0	Q
0	1	Q
1	0	0
1	1	1



Aufgabe 3

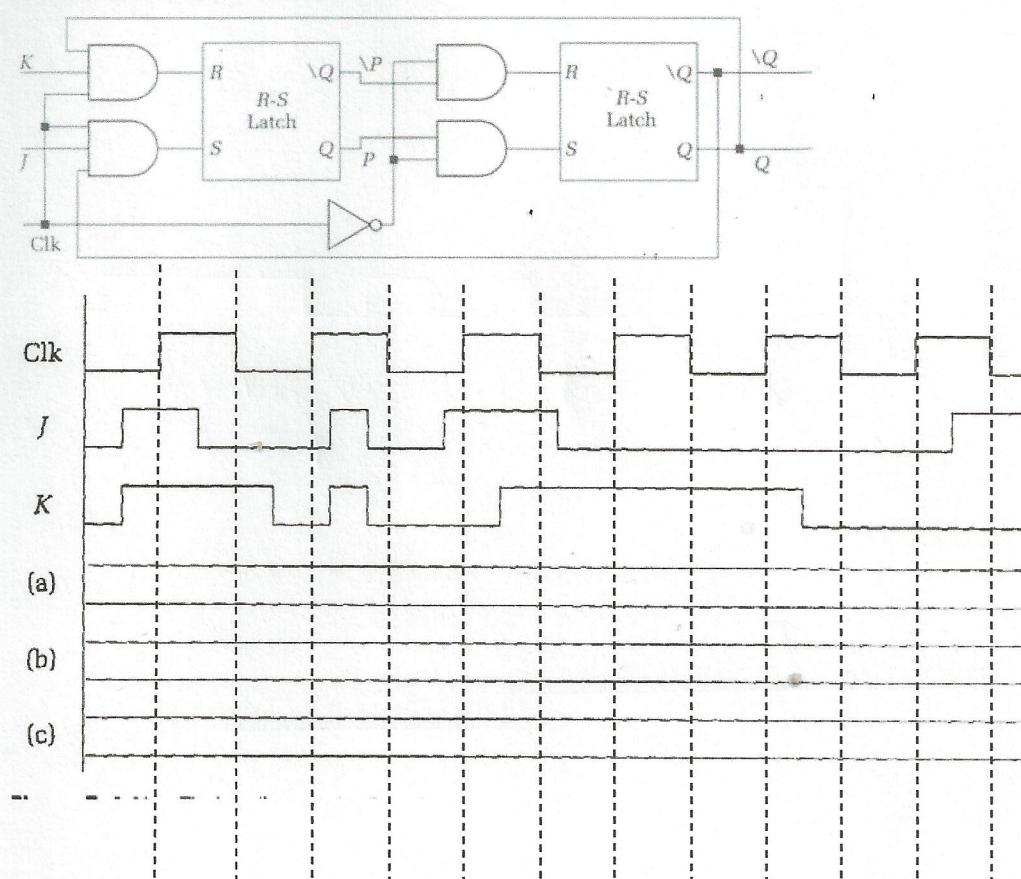
Zeichen Sie den Ausgang Q für folgende JK-FF-Typen (Initialzustand Q=0):

a) Master/Slave zustandsgetriggert

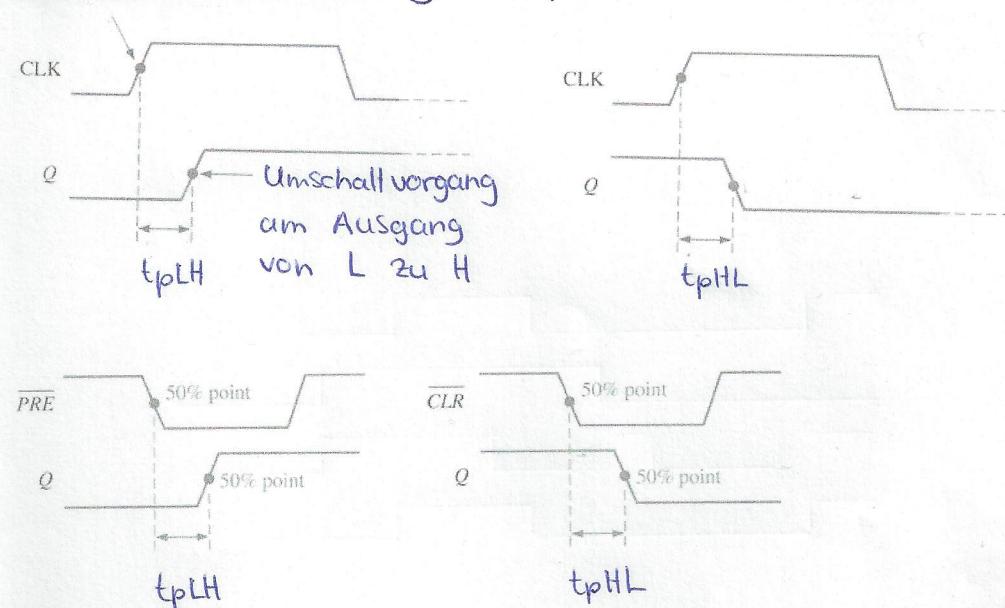
b) negativ flankengetriggert

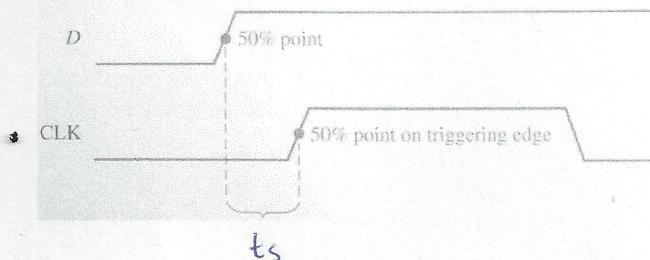
c) positiv flankengetriggert

Interne Struktur eines JK-FFs

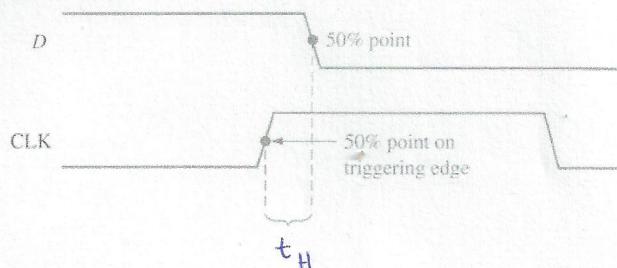
**1.4 Dynamisches Verhalten**Propagation Delay Time [Signallaufzeit]

Gatterlaufzeit: baulich bedingt



Set-up Time

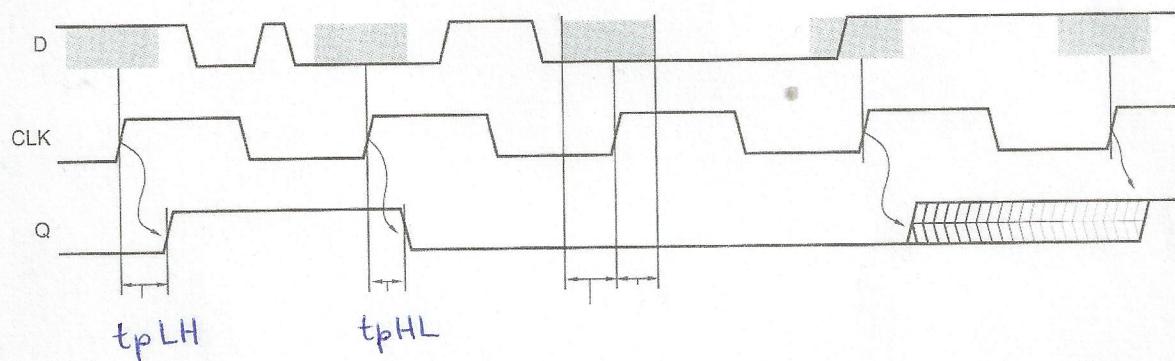
Das Eingangssignal darf sich vor der aktiven Schaltflanke des Taktsignals für eine definierte Mindestdauer t_S nicht ändern!

Hold Time

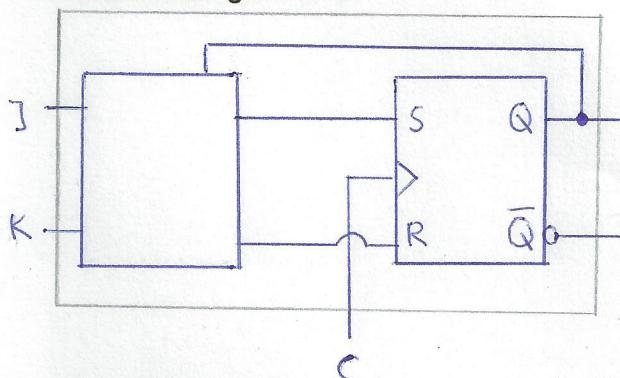
Der Logikzustand am Eingang darf sich nach der aktiven Schaltflanke des Taktsignals für eine definierte Mindestdauer t_H ebenfalls nicht ändern!

Beispiel D-FF

10.11.15

**1.5 Konvertierung von Flip-Flop**Konvertierung eines RS- in ein JK-FF

Konvertierungsstruktur



Zustände

Zustandstabelle

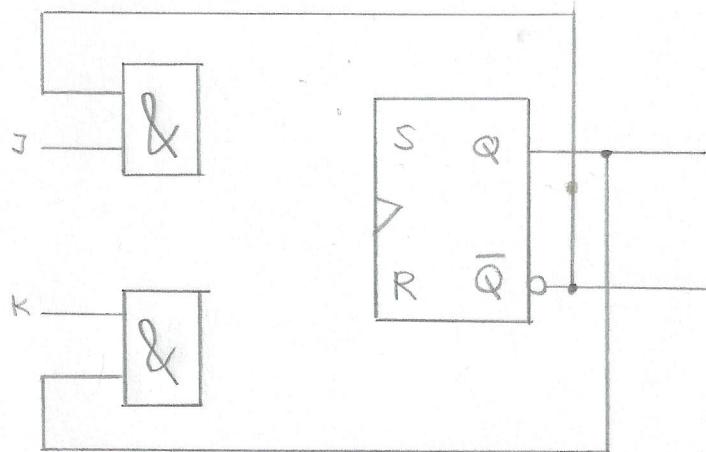
J	K	Q	\bar{Q}	S	R
0	0	0	0	0	x
0	0	1	1	x	0
0	1	0	0	0	x
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	1	x	0
1	1	0	1	1	0
1	1	1	0	0	1

RS-FF

		J	
		Q	
S = J \bar{Q}			
S	Sp	0	x
R	Sp	0	0
S	Sp	0	x
R	Sp	0	1

		J	
		Q	
R = KQ			
S	Sp	x	0
R	Sp	0	0
S	Sp	x	0
R	Sp	1	0

Schaltbild



Aufgabe 4

Gegeben ist ein getaktetes T-FF mit folgender Funktionstabelle:

T	Q	\bar{Q}
0	0	0
0	1	1
1	0	1
1	1	0

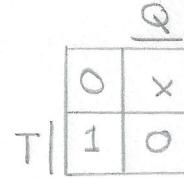
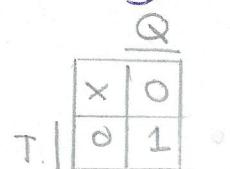
$Q \bar{Q}$	S	R
0 0	0	x
0 1	1	0
1 0	0	1
1 1	x	0

Entwerfen Sie dieses T-FF auf Basis eines RS-FFs.

a) Stellen Sie die Wahrheitstabelle auf:

T	Q	\bar{Q}	R	S
0	0	0	x	0
0	1	1	0	x
1	0	1	0	1
1	1	1	1	0

KV-Diagramm

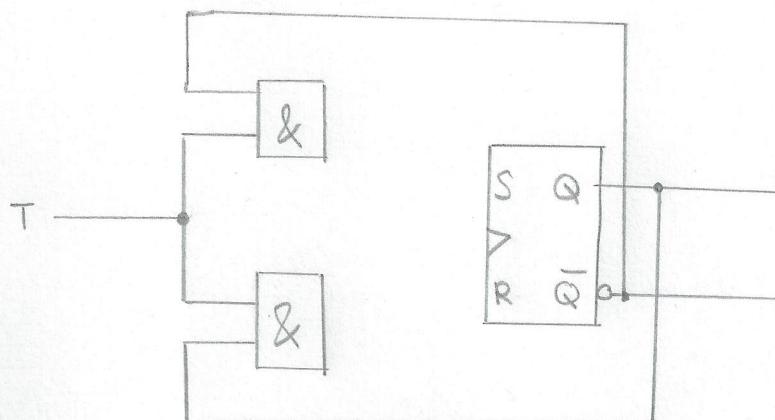


b) Geben Sie die minimierte Schaltfunktion der Zusatzbeschaltung an:

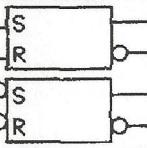
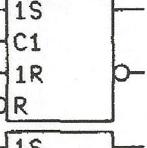
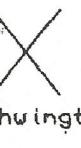
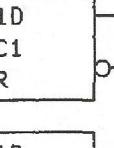
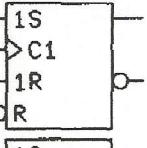
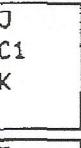
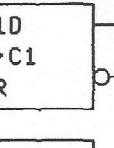
$$R = TQ$$

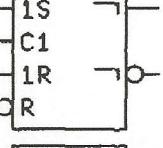
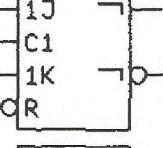
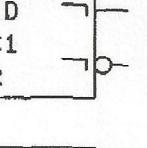
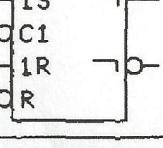
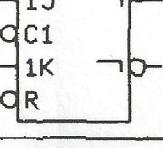
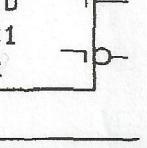
$$S = T\bar{Q}$$

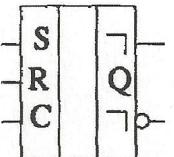
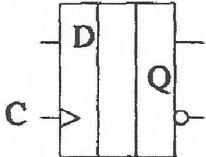
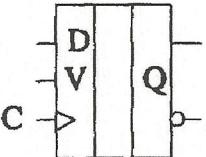
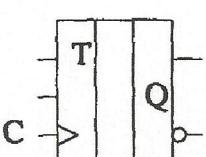
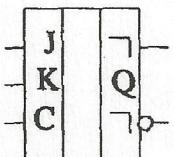
c) Zeichnen Sie die Schaltung.



1.6 Zusammenfassung der FFs

	RS-FF	JK-FF	D-FF
FF ohne Taktsteuerung	  	(Schwingt!)	(Leitende Verbindung !)
Einzustands-gesteuerte FF	  	(Schwingt!)	
Einflanken-gesteuerte FF	  		

	RS-FF	JK-FF	D-FF
Zweizustands-gesteuerte FF	  		
Zweiflanken-gesteuerte FF	  		

FF-Typ	Schaltbild (Beispiele)	reduzierte Wahrheitstabelle	Schaltfunktion
RS		$\begin{array}{c cc} Q & \bar{Q} \\ \hline 0 & 0 \\ 1 & d \end{array}$ $\begin{array}{c cc} S & R \\ \hline 0 & 0 \\ 1 & 1 \\ 0 & 0 \\ 1 & 1 \end{array}$	$\bar{Q} = S + \bar{R}Q$ $R \cdot S = 0$
D		$\begin{array}{c cc} Q & \bar{Q} \\ \hline 0 & 0 \\ 1 & 1 \\ 0 & 0 \\ 1 & 1 \end{array}$	$\bar{Q} = D$
DV		$\begin{array}{c ccccc} Q & \bar{Q} & C & V & D \\ \hline 0 & 0 & 0 & d & d \\ 0 & 0 & d & 0 & d \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & d & d \\ 1 & 1 & d & 0 & d \end{array}$	$\bar{Q} = \bar{C}Q + \bar{V}Q + CVd$
T		$\begin{array}{c cc} Q & \bar{Q} \\ \hline 0 & 0 \\ 1 & d \\ 0 & d \\ 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{array}$	$\bar{Q} = \bar{C}Q + \bar{T}Q + T\bar{C}Q$
JK		$\begin{array}{c cc} Q & \bar{Q} \\ \hline 0 & 0 \\ 1 & d \\ 0 & d \\ 1 & 1 \end{array}$	$\bar{Q} = J\bar{Q} + \bar{K}Q$

