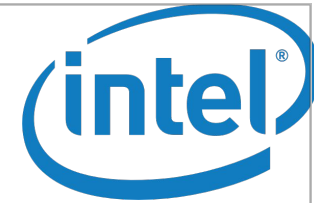


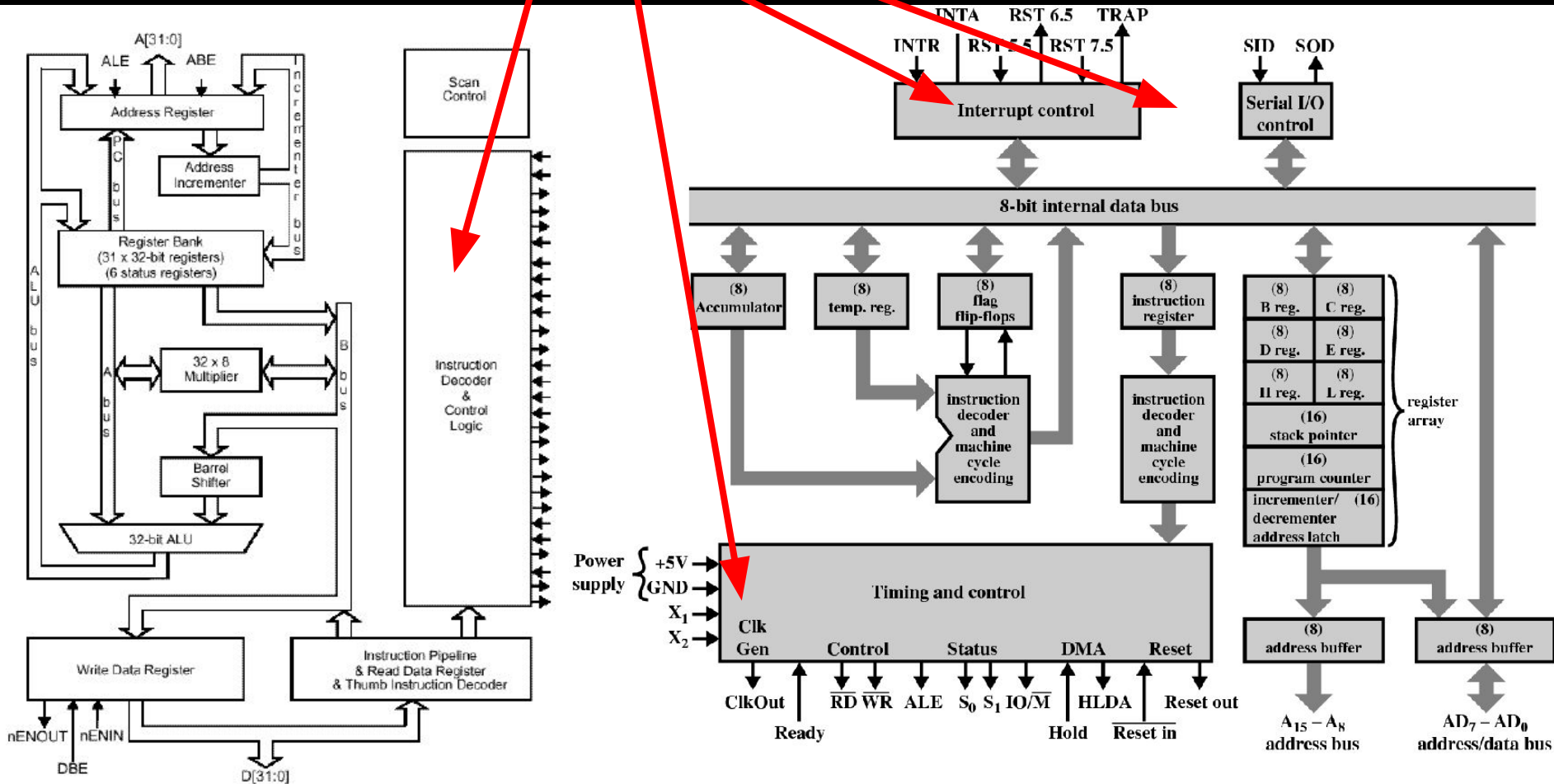
Chapter 8 Algorithmic State Machines



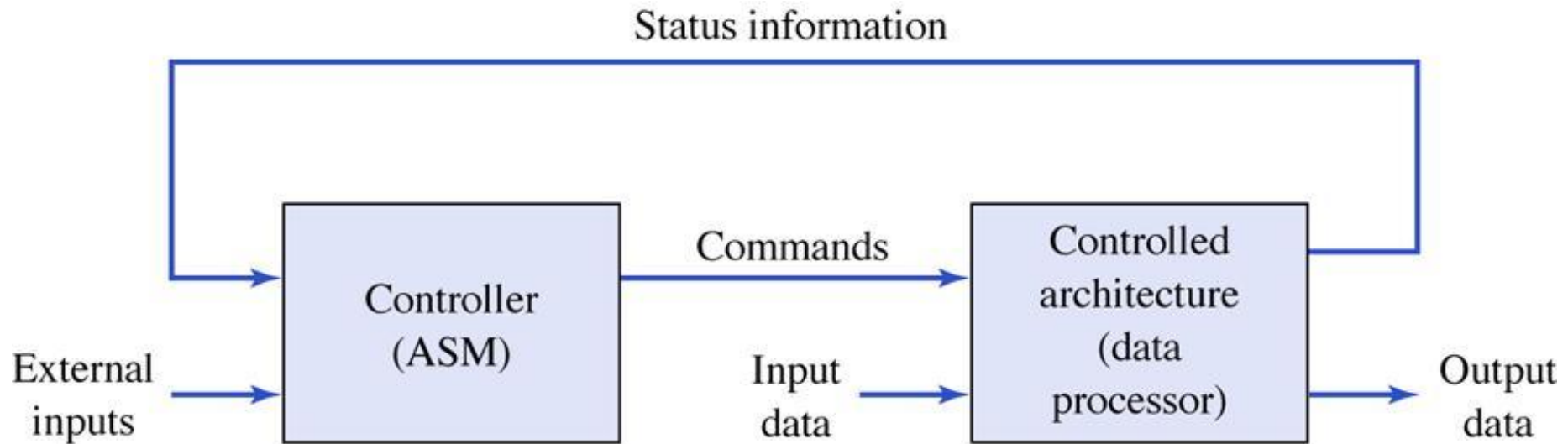
ARM[®]



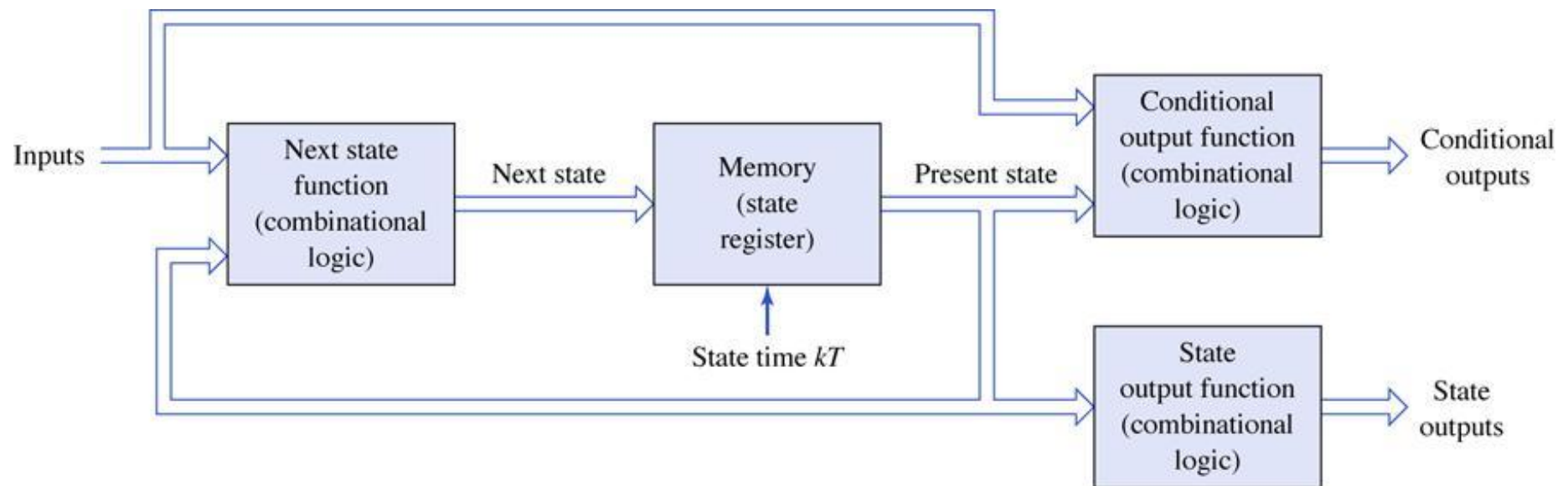
Chapter 8 Algorithmic State Machines



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Algorithmic State Machine DataPath Chart

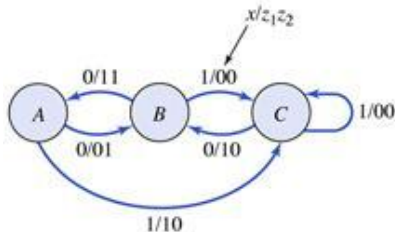
Link Table

Don't attempt, assume unique states

State Locus ... easier .. no rules

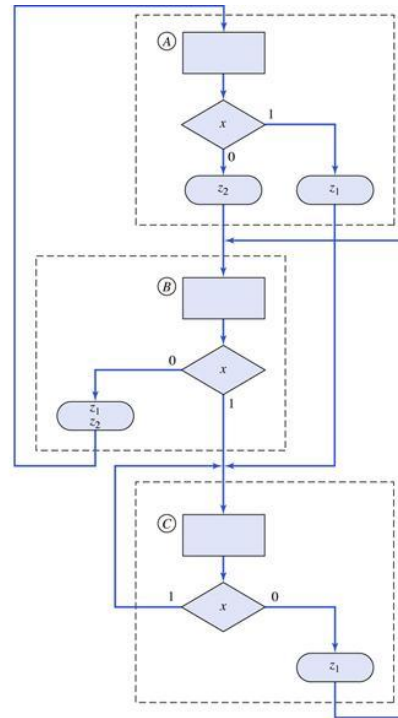
Same, usually more input don't cares

Chapter 8 Algorithmic State Machines

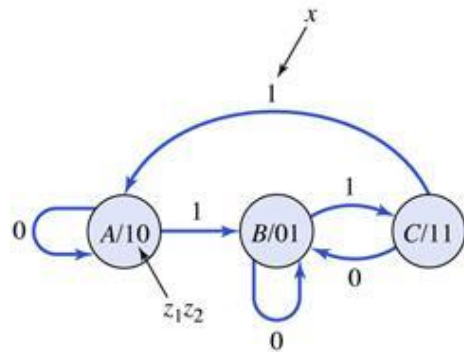


MEALY

Notice outputs (z) in
Conditional Output Box

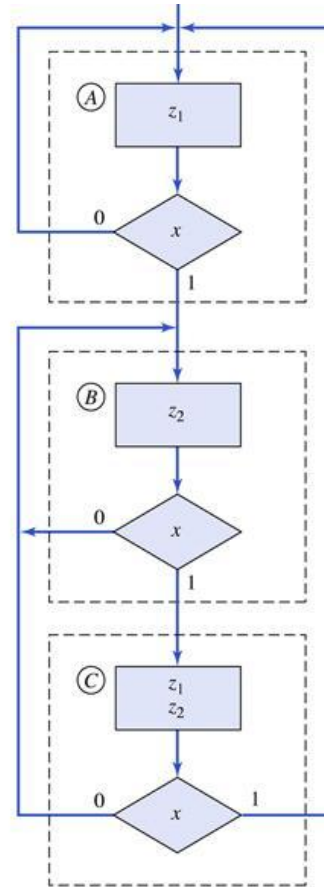


Chapter 8 Algorithmic State Machines

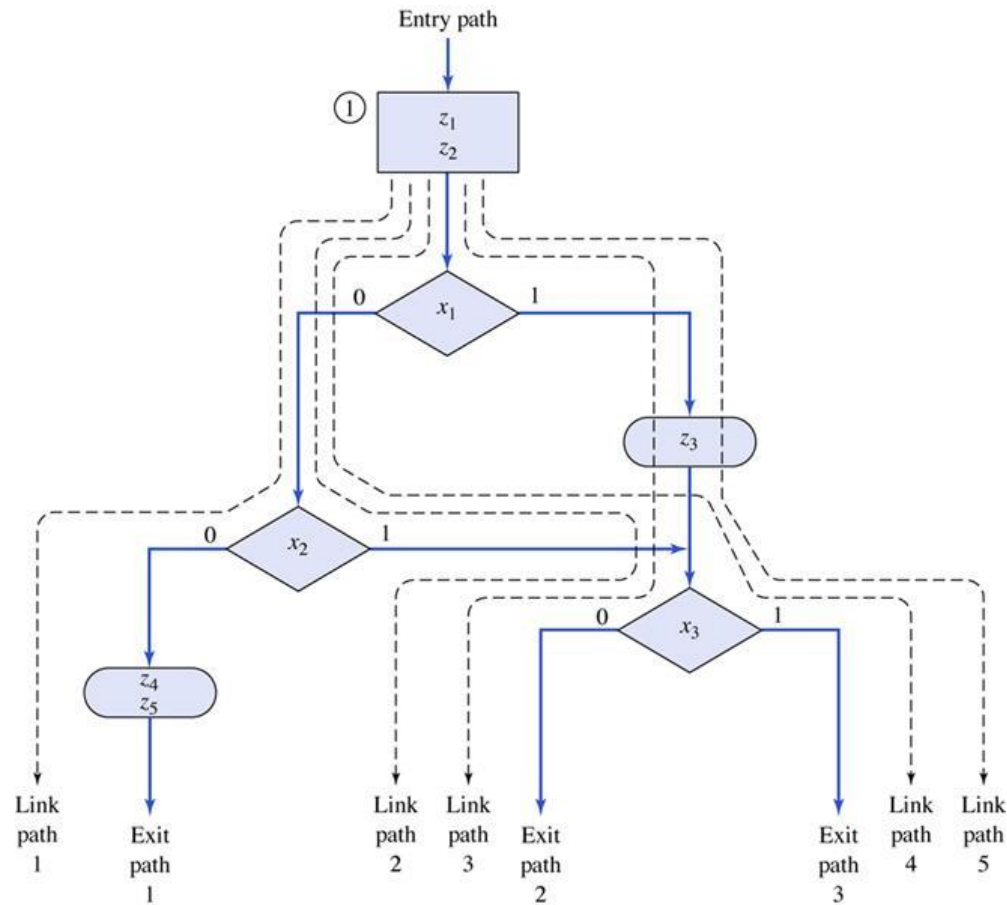


MOORE

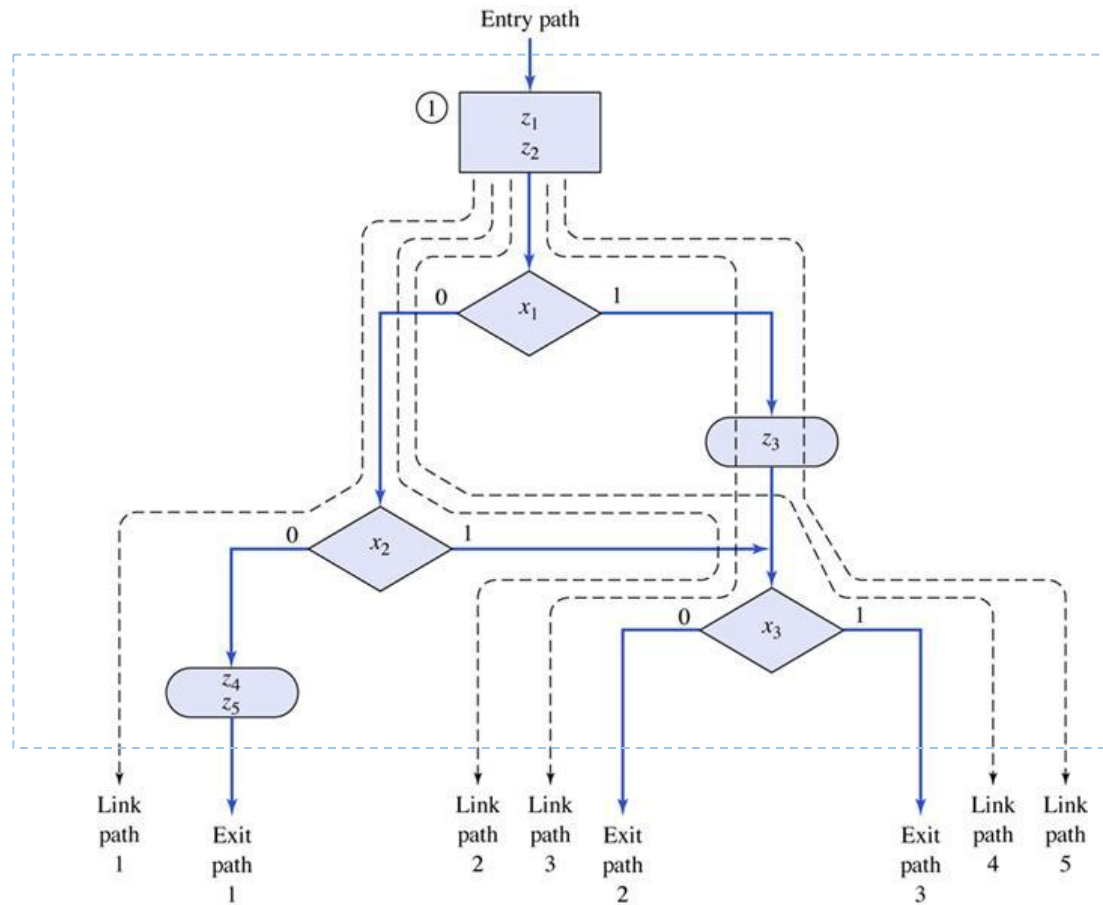
Notice output (z) is in
state box



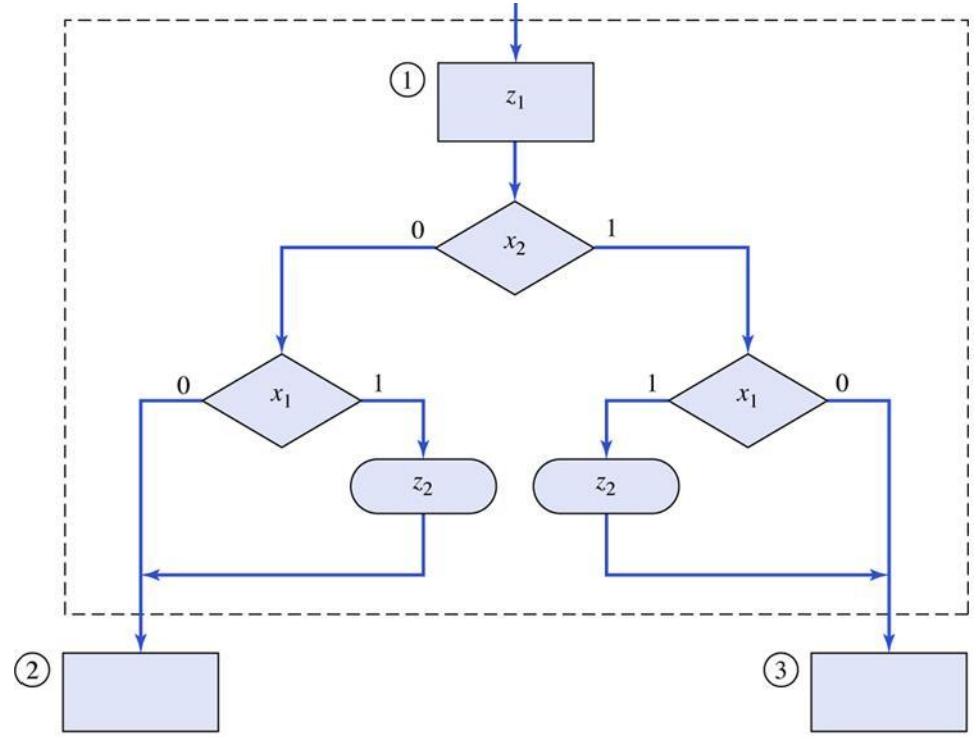
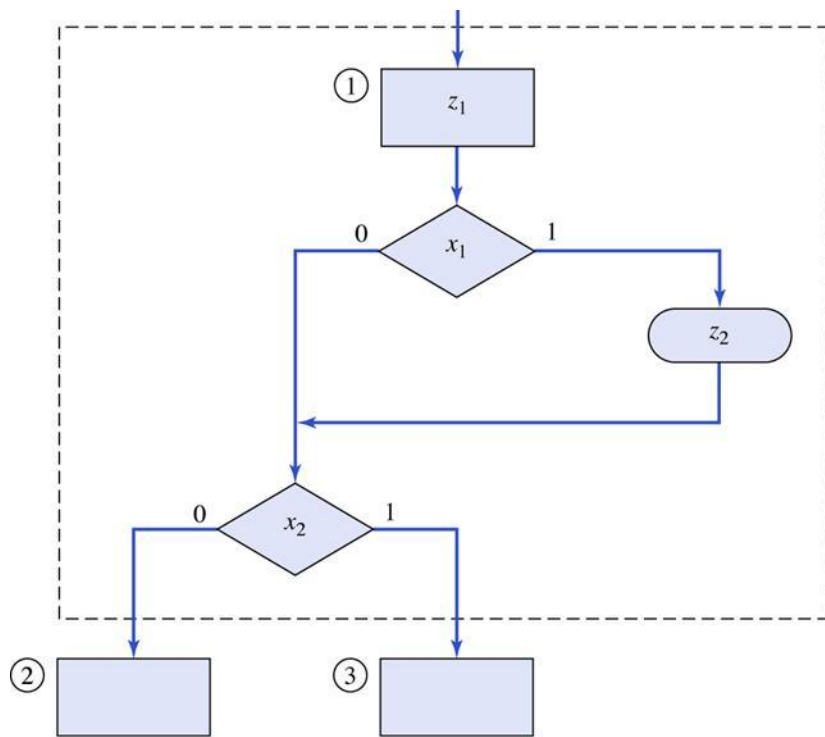
Chapter 8 Algorithmic State Machines



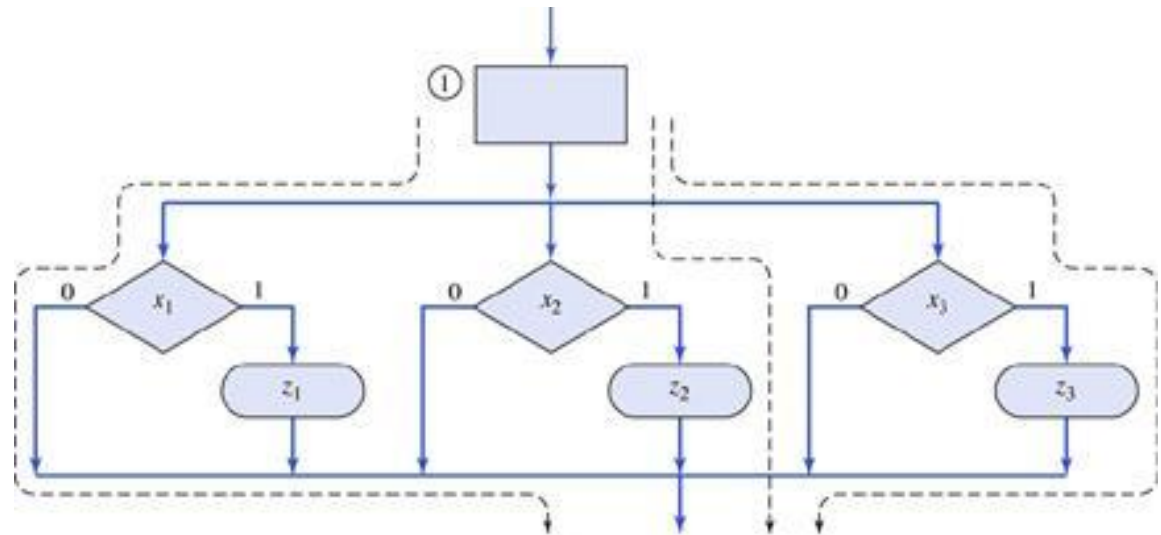
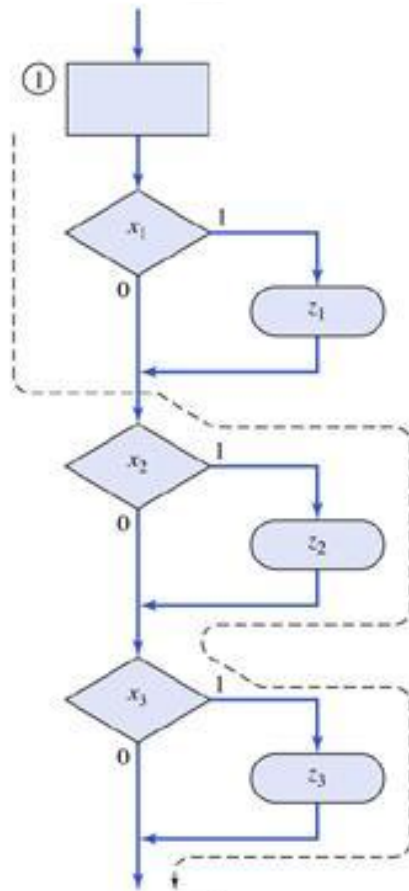
Chapter 8 Algorithmic State Machines



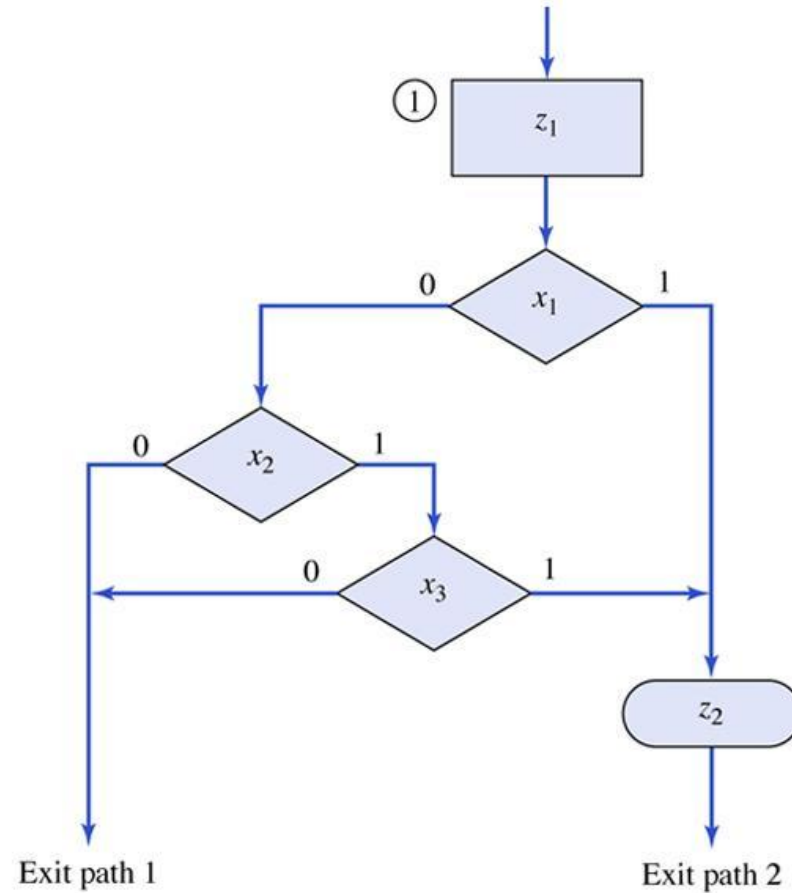
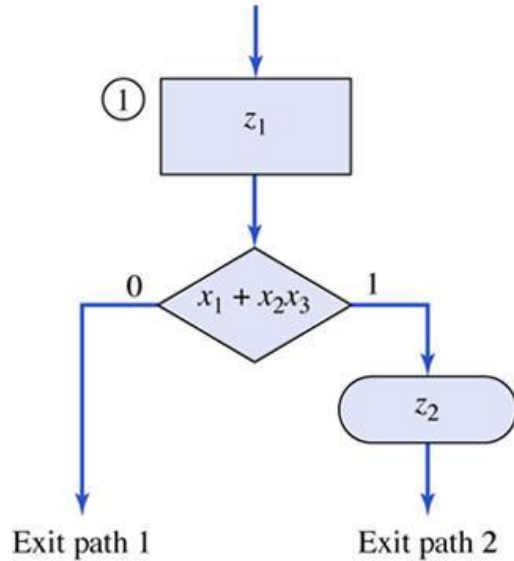
Chapter 8 Algorithmic State Machines



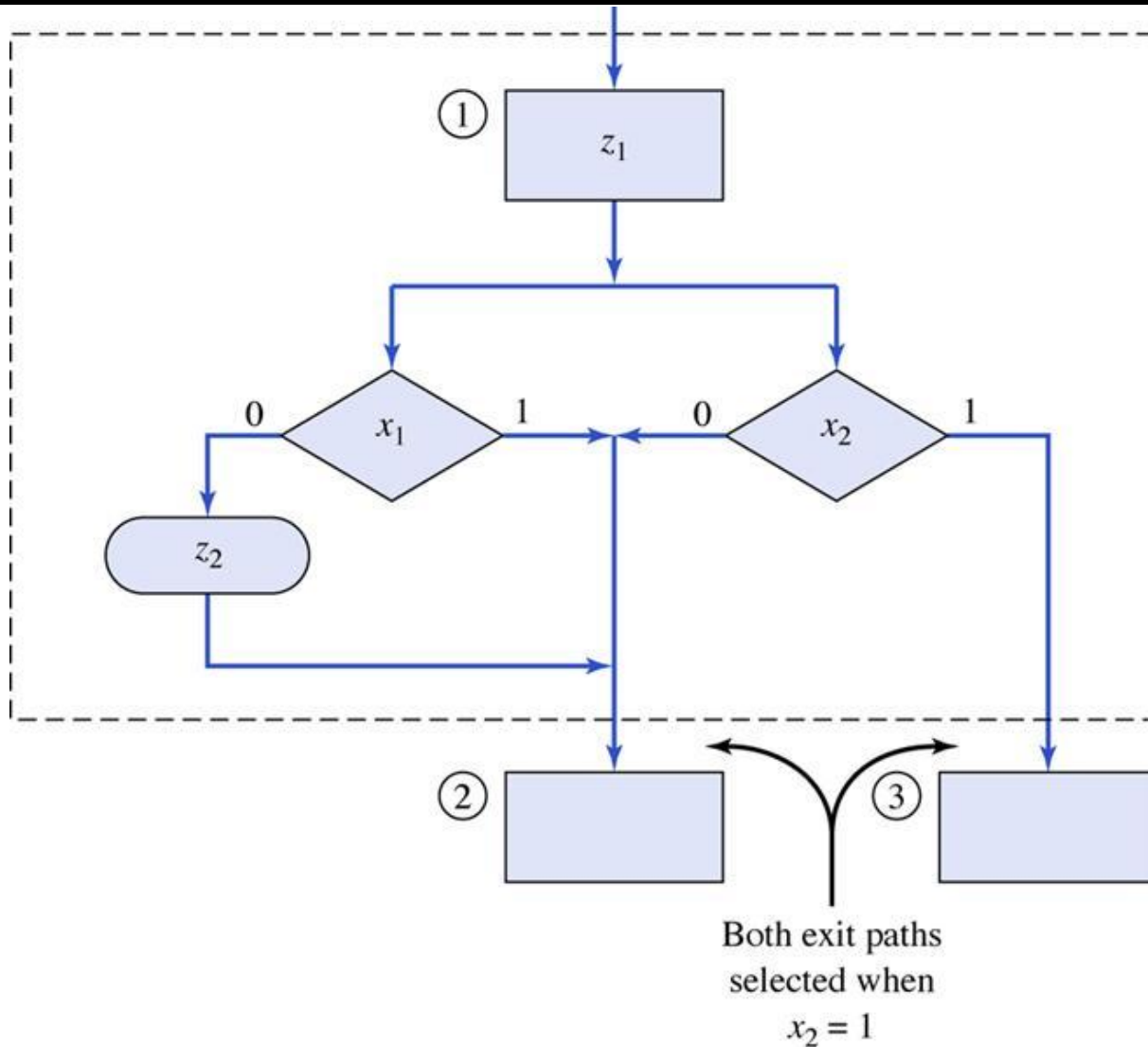
Chapter 8 Algorithmic State Machines



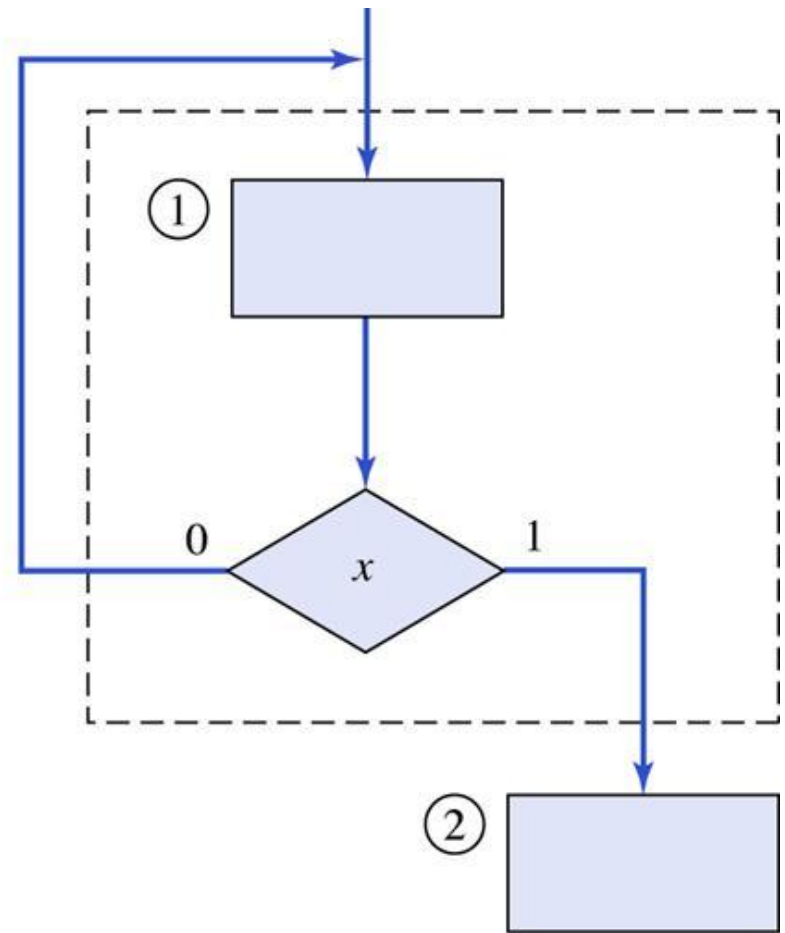
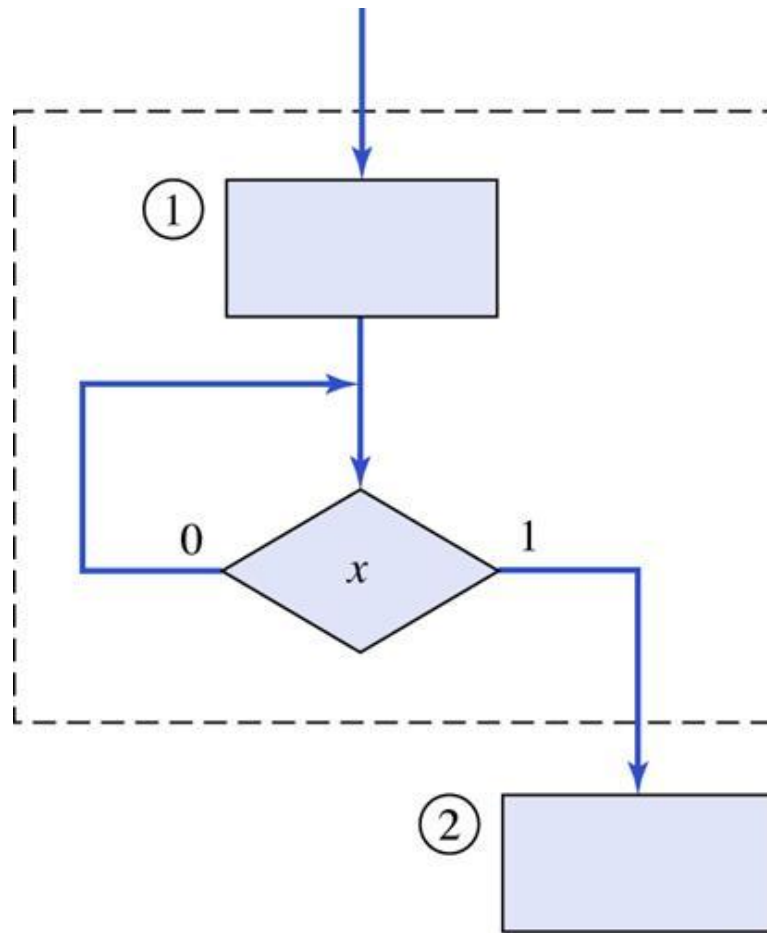
Chapter 8 Algorithmic State Machines



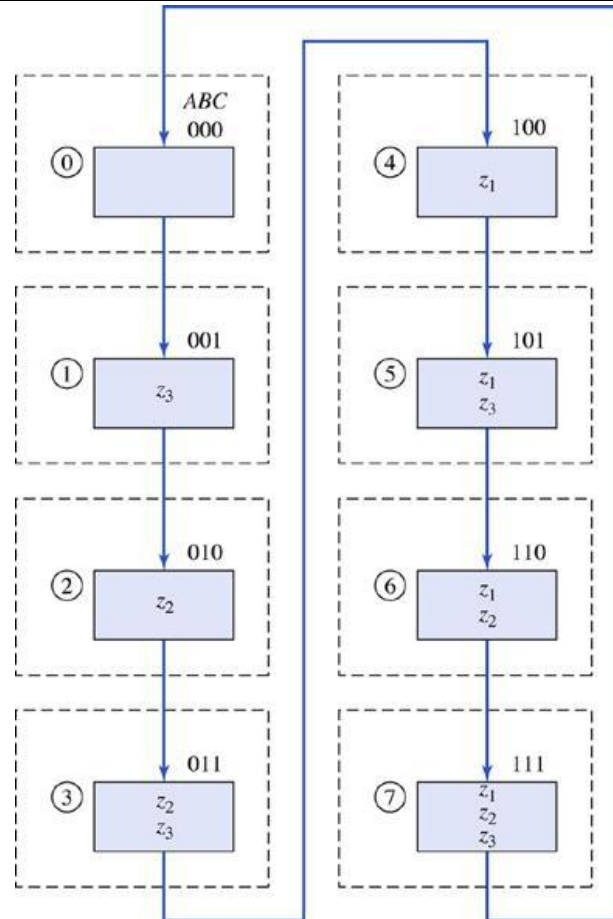
Chapter 8 Algorithmic State Machines



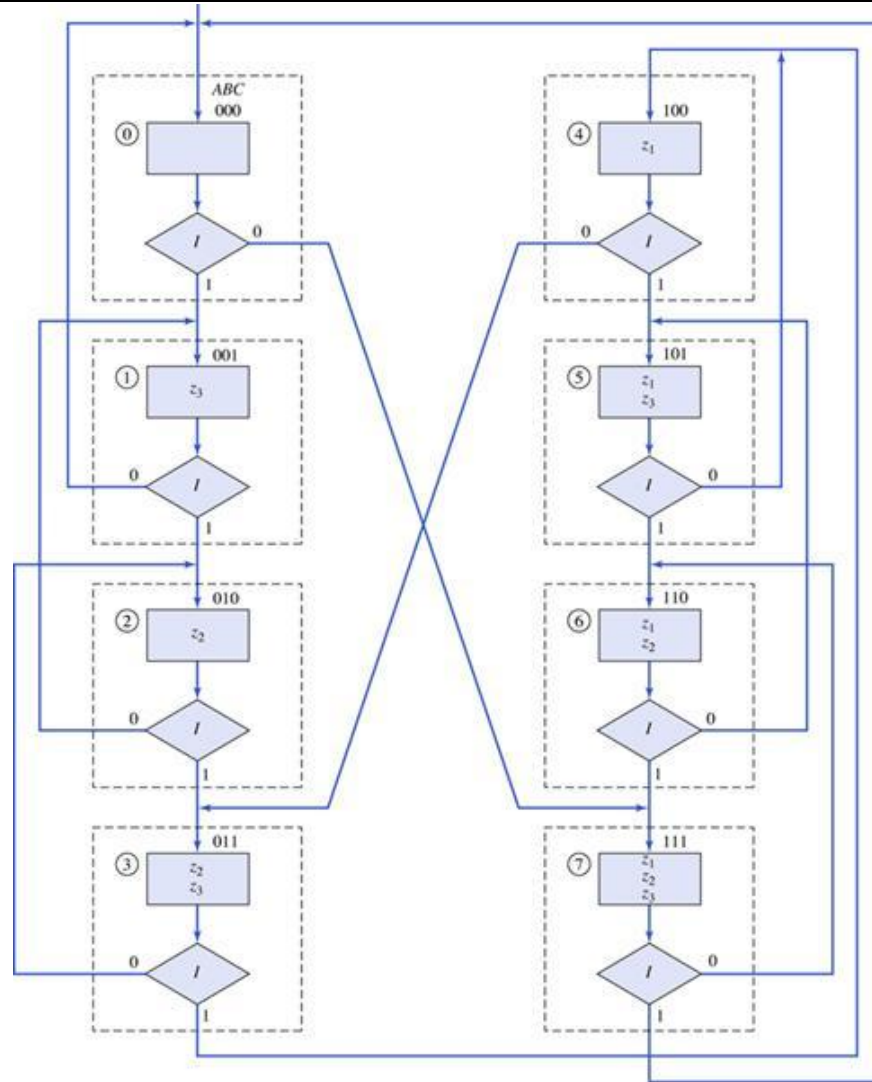
Chapter 8 Algorithmic State Machines



Chapter 8 Algorithmic State Machines

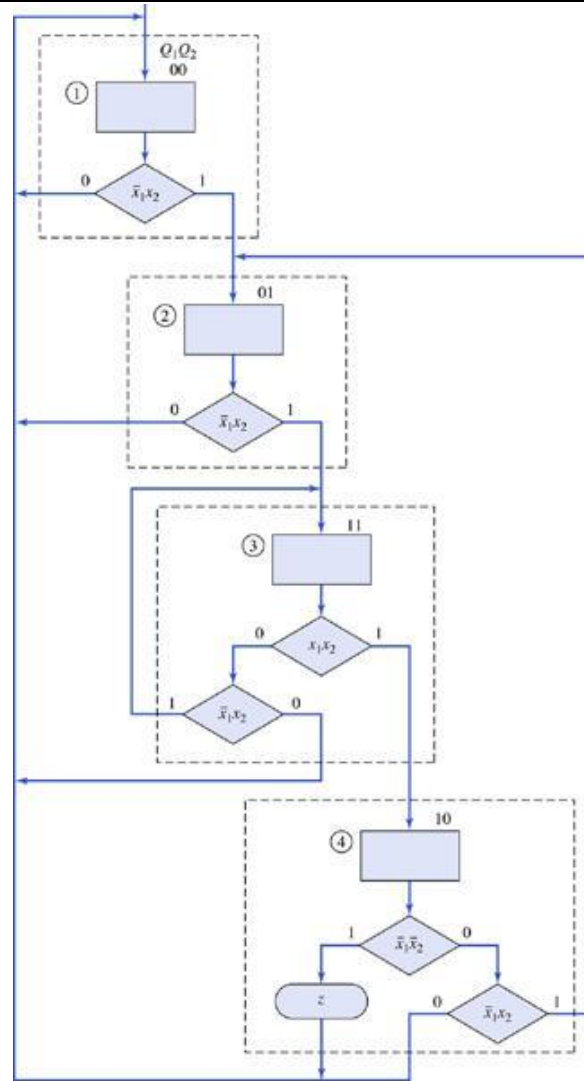


Chapter 8 Algorithmic State Machines

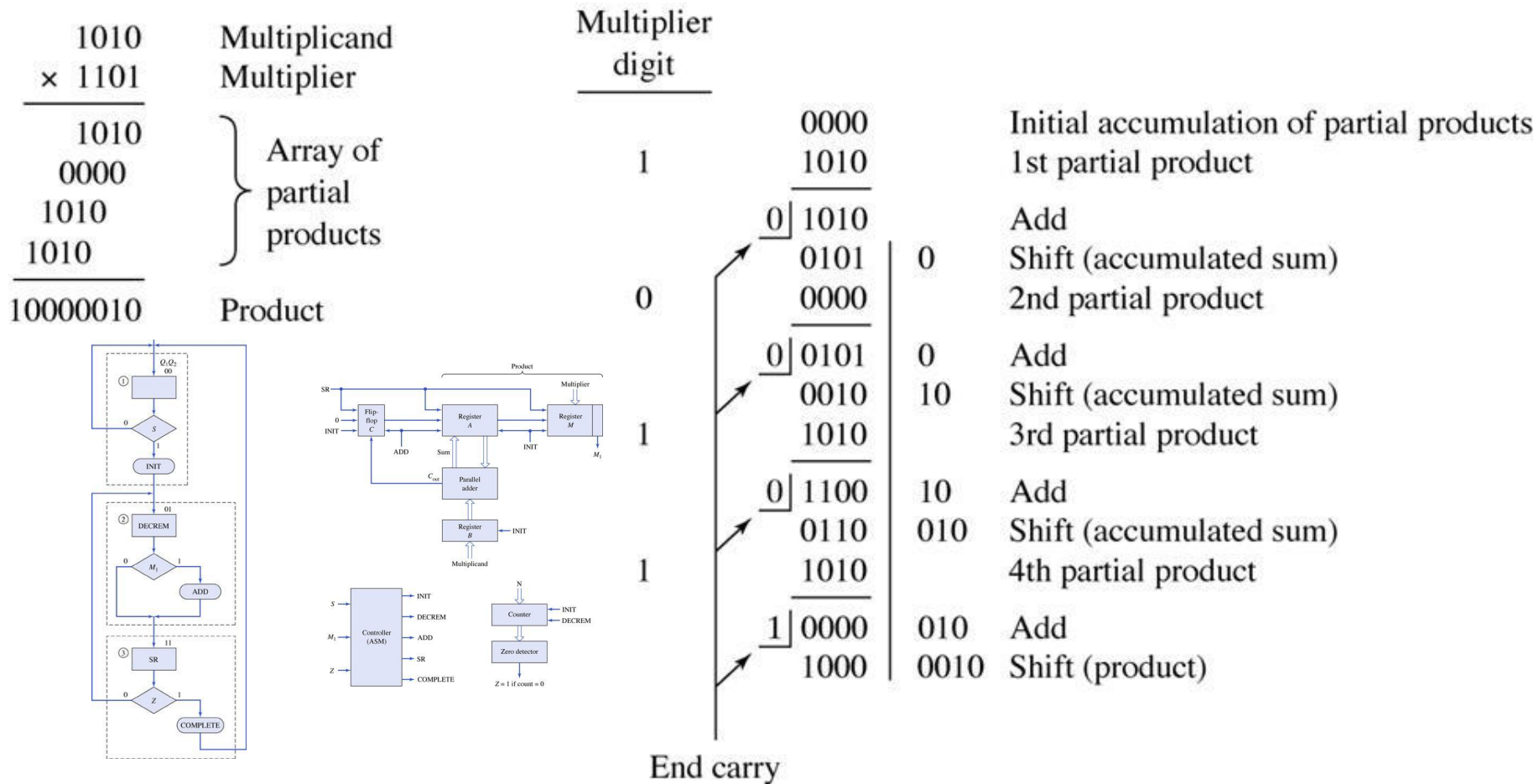


Chapter 8 Algorithmic State Machines

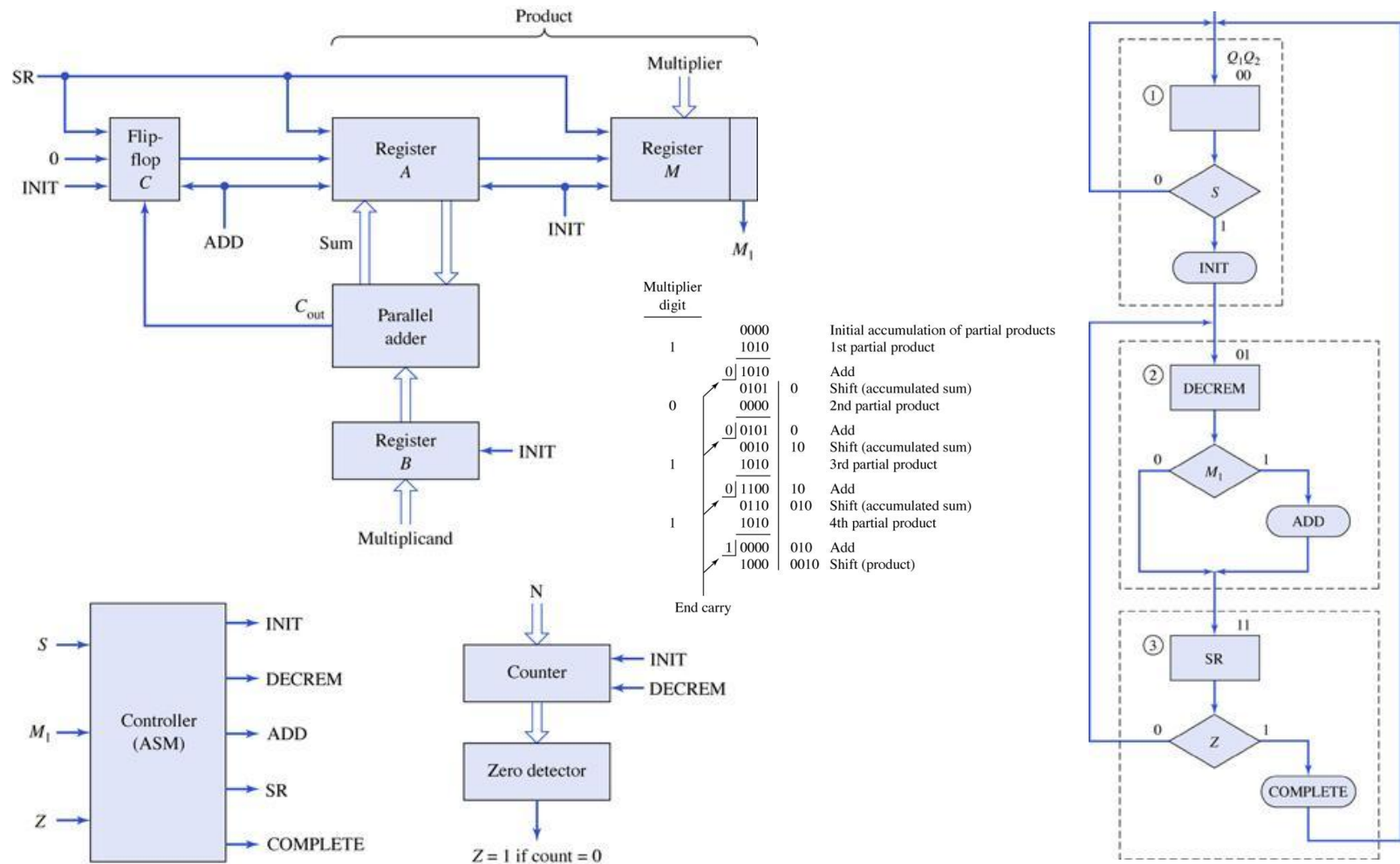
ASM chart to recognize the sequence $x_1x_2 = 01, 01, 11, 00$



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TIMING

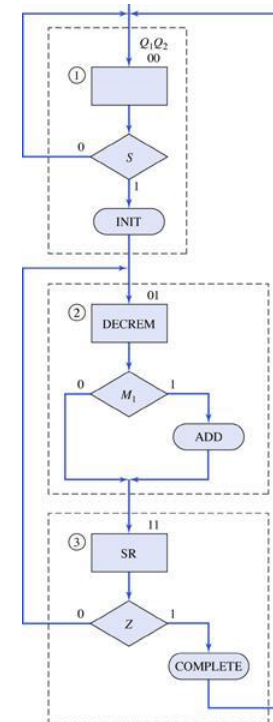
ASM timing is important to understand before building any circuits.

Nothing happens within an ASM state .. except Mealy inputs cause next states to be setup.

For example look at ASM3. **SR** (shifting right) doesn't happen within the state. **SR** happens between ASM3->ASM2 or ASM3->ASM1. **SR** happens no matter what because it is Moore.

Complete doesn't happen within ASM3. **Complete** only happens between ASM3 -> ASM1.

Everything happens on the rising clock edge between states.



Chapter 8 Algorithmic State Machines

Mealy Inputs

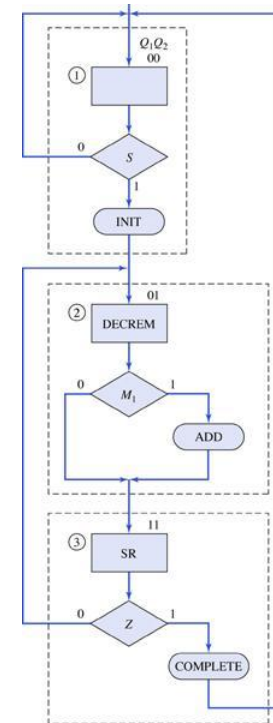
The S, M₁ and Z inputs are examined at each state.

It appears that M1 is only looked at in ASM2. But in fact it could cause another add between ASM3->ASM2 or ASM3->1 even though it is not mentioned.

Rules: Enable inputs only for their states. Keep ASM states simple. Keep the ASMD machines small.

ASYNCR

The ASM circuit will be synchronous, but it could be controlling circuits with evil ASNYC elements. These cause Moore commands to be executed both entering and leaving the state. For example ASM2 Decrement is executed both in the transition into ASM2 from ASM3 and in leaving ASM2 for ASM3 if an async counter is used.



Chapter 8 Algorithmic State Machines

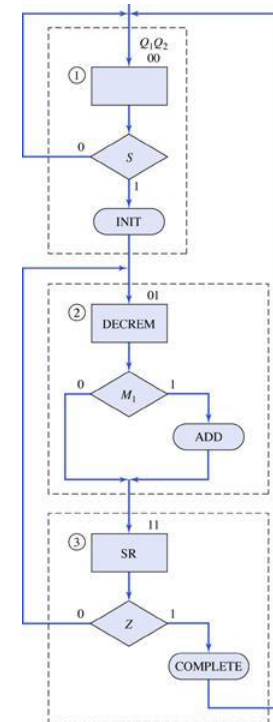
Mealy and Moore just set

The boxes (Moore:Decrem, SR and Mealy: Init, Add and Complete) are setting a logical true in a wire so that Decrem, SR, Init, Add and Complete happen on the next rising edge of a clock.

These outputs/wires have to hold their value through the next clock trigger.

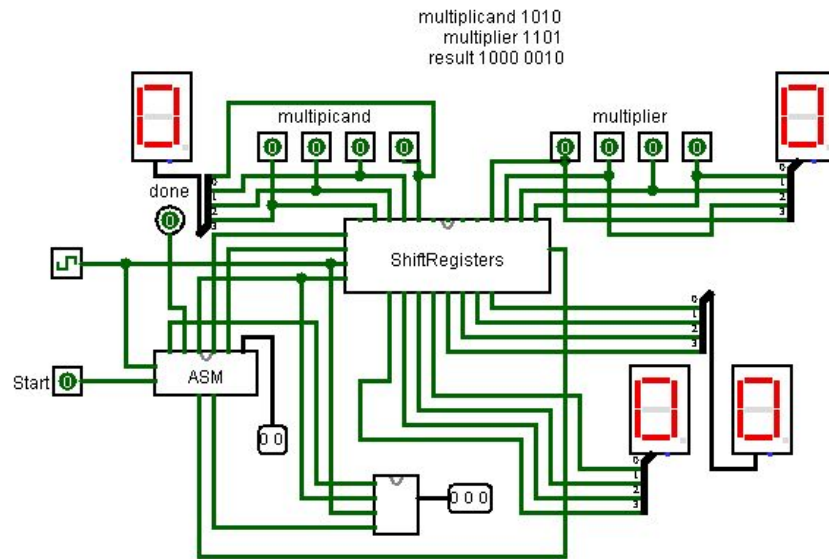
The clock trigger and next state could change their value.

But these “sets” must not be confused with the actual operation of Decrem, SR, Init, Add and Complete .. done by other circuits or additions to the ASM.



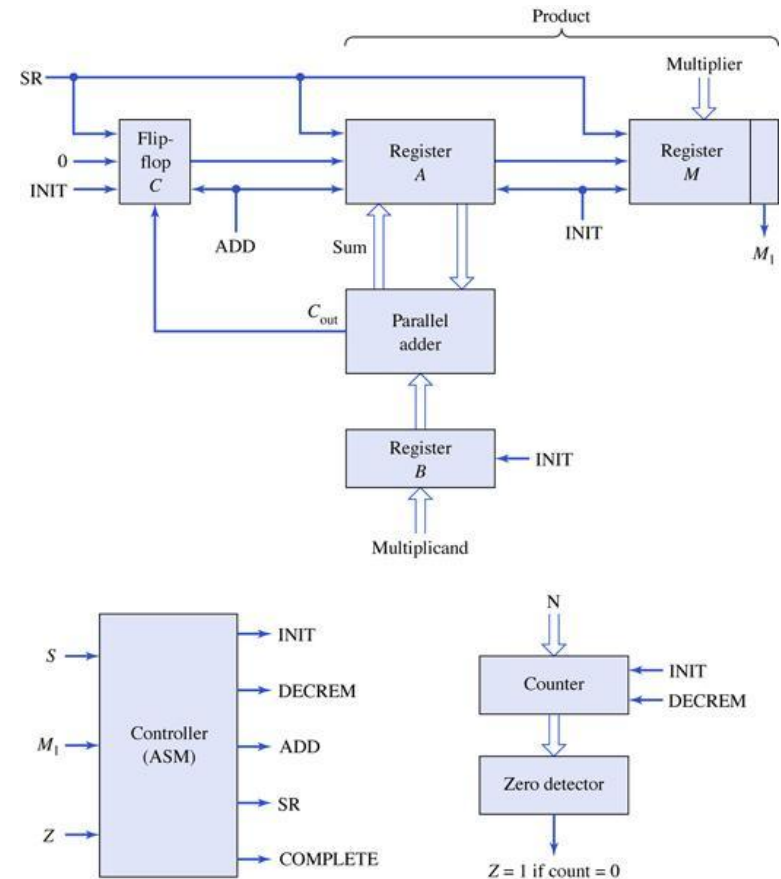
Chapter 8 Algorithmic State Machines

ASM Multiply Sync Counter

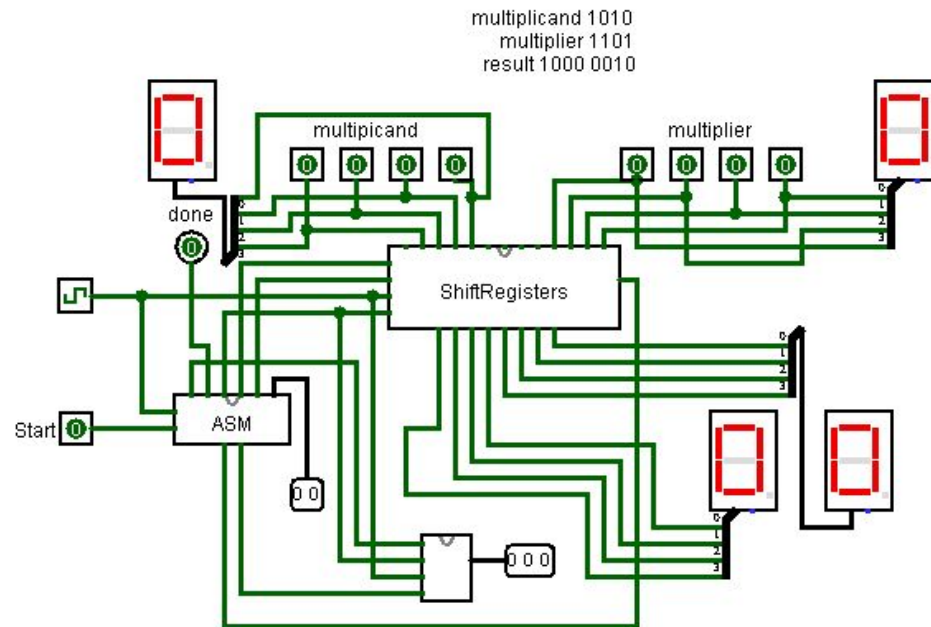


To start, S has to be 1 for one clock tick, then value doesn't matter.
To Start over, S has to be 0 for at least one clock tick.
After starting, S value doesn't matter
After starting, multiplicand and multiplier registers can be used for another purpose.

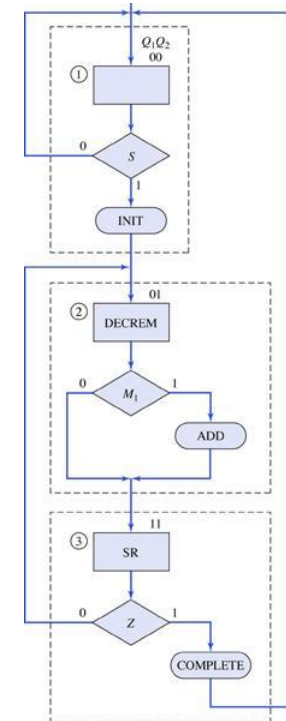
ASM Multiply Async Counter



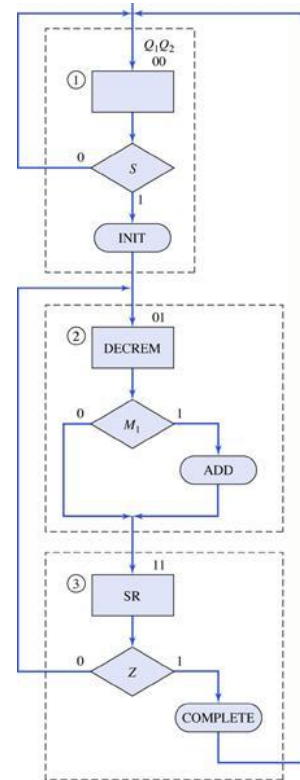
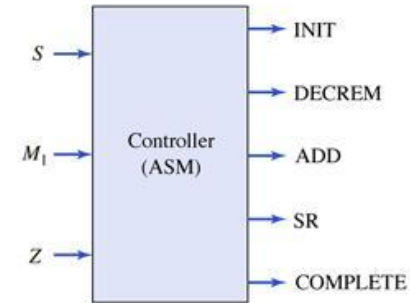
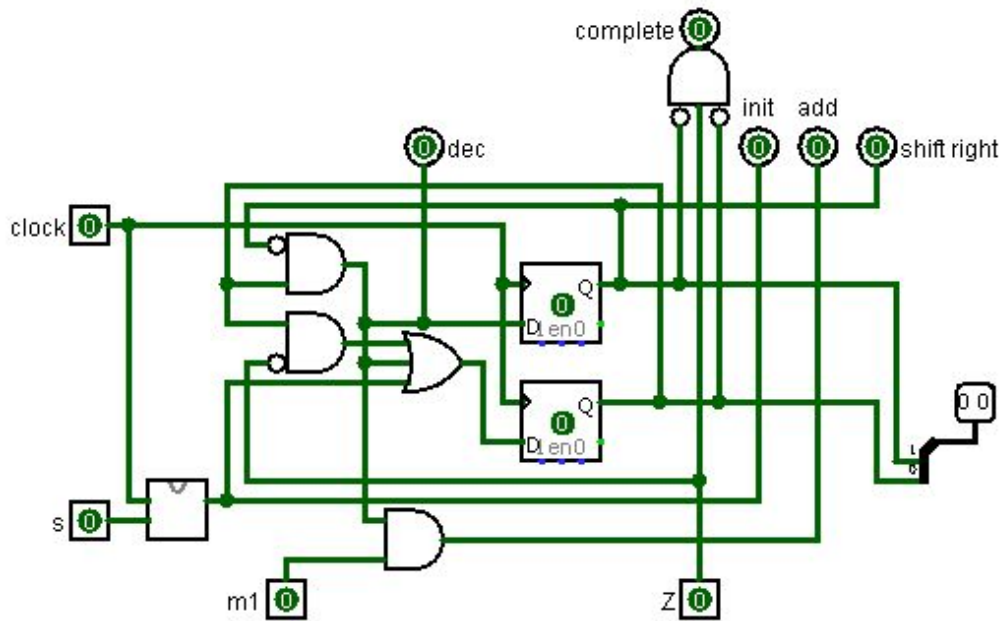
Chapter 8 Algorithmic State Machines



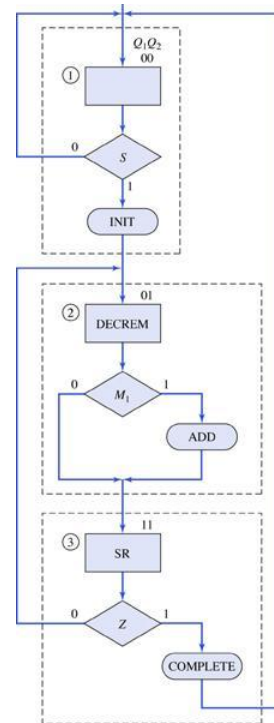
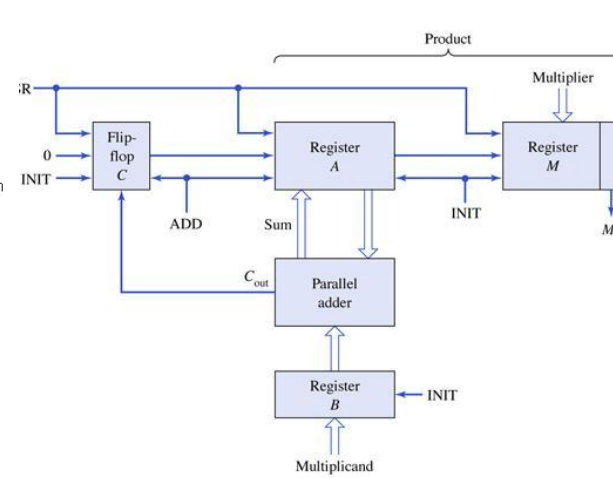
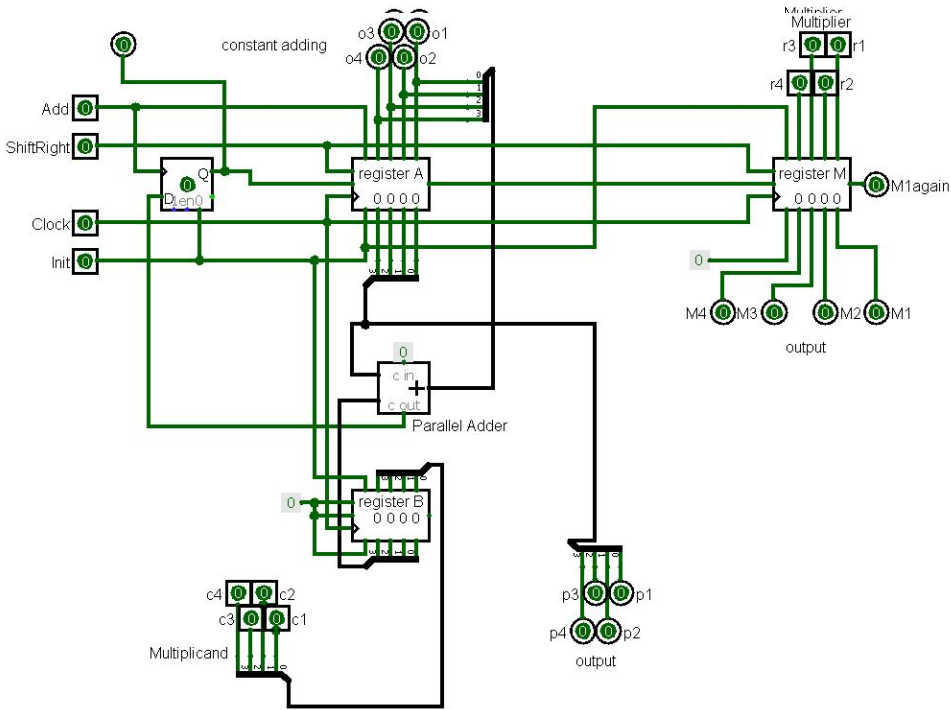
To start, S has to be 1 for one clock tick, then value doesn't matter.
 To Start over, S has to be 0 for at least one clock tick.
 After starting, S value doesn't matter
 After starting, multiplicand and multiplier registers can be used for another purpose.



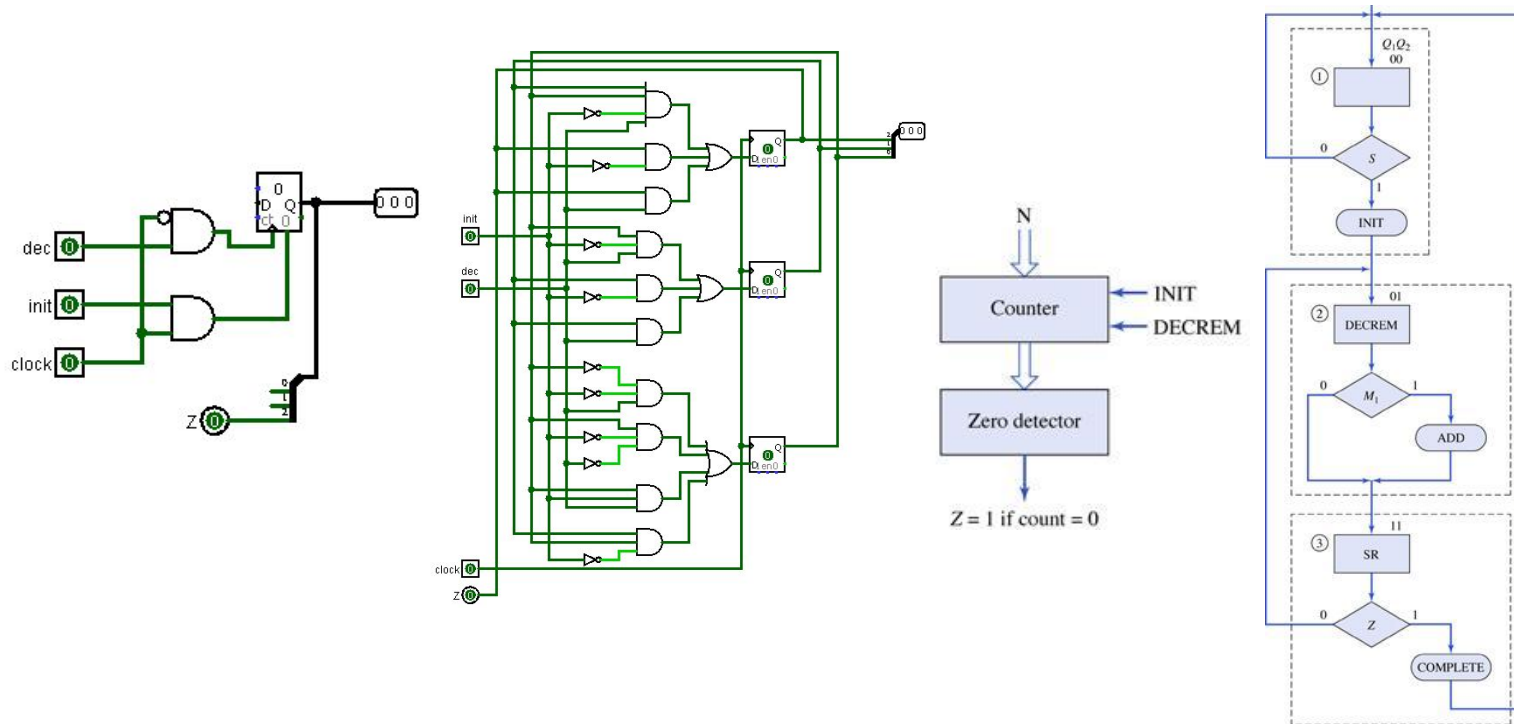
Chapter 8 Algorithmic State Machines



Chapter 8 Algorithmic State Machines



Chapter 8 Algorithmic State Machines



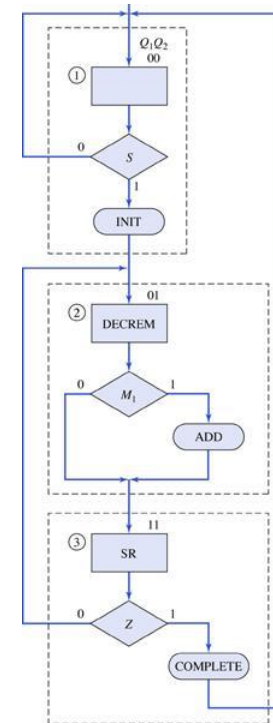
Chapter 8 Algorithmic State Machines

TIMING Nothing happens within an ASM state

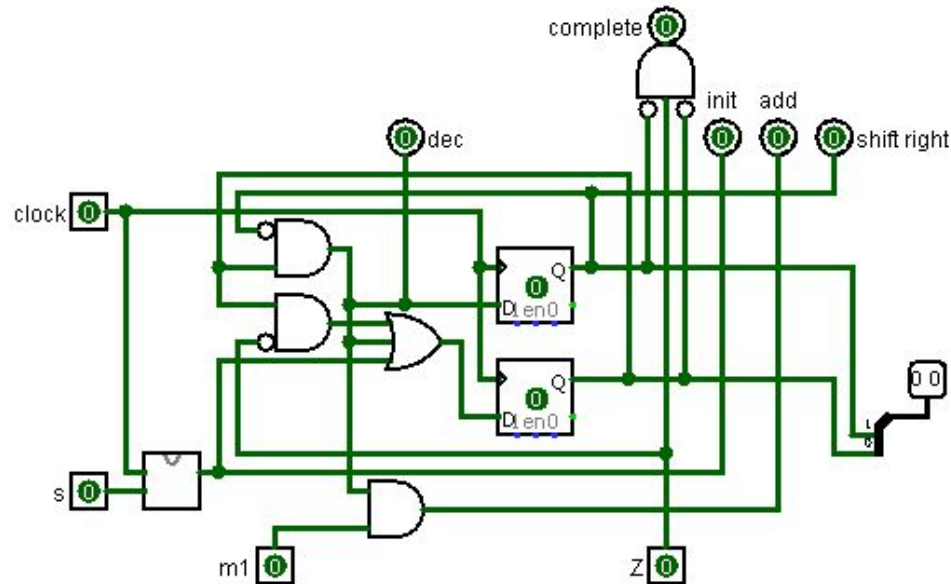
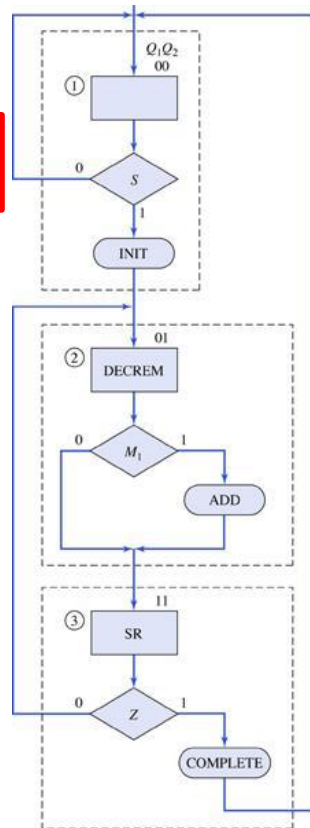
Mealy and Moore just set

Mealy Inputs Inputs are examined at each state.
Enable inputs only for their states.

ASync **Evil**

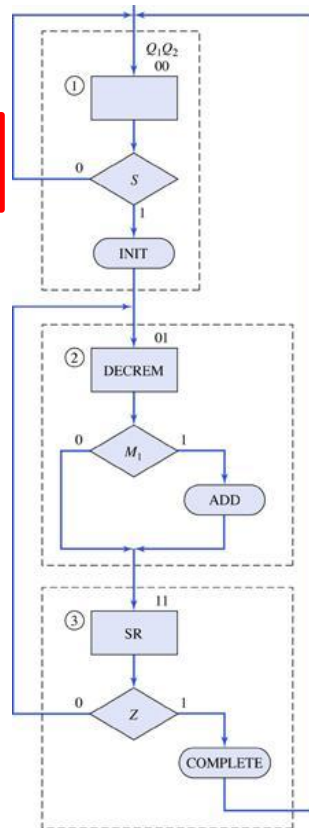


Chapter 8 Algorithmic State Machines



Chapter 8 Algorithmic State Machines

given ASMD, draw Link/DataPath Table (State Table)



Chapter 8 Algorithmic State Machines

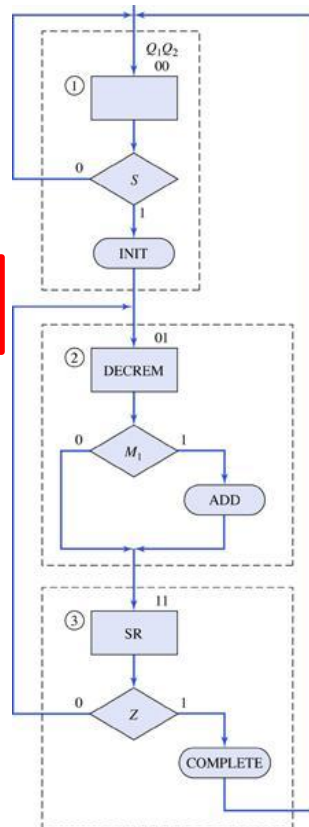


Table 8.2 ASM tables for Fig. 8.20. (a) ASM transition table. (b) Assigned ASM transition table

Link path	Present state	S	Inputs M_1	Z	Next state	INIT	DECREM	Outputs ADD	SR	COMPLETE
L_1	1	0	—	—	1	0	0	0	0	0
L_2	1	1	—	—	2	1	0	0	0	0
L_3	2	—	0	—	3	0	1	0	0	0
L_4	2	—	1	—	3	0	1	1	0	0
L_5	3	—	—	0	2	0	0	0	1	0
L_6	3	—	—	1	1	0	0	0	1	1

Chapter 8 Algorithmic State Machines

Link path	Present state	S	Inputs M_1	Z	Next state	INIT	DECREM	Outputs ADD	SR	COMPLETE
L_1	1	0	—	—	1	0	0	0	0	0
L_2	1	1	—	—	2	1	0	0	0	0
L_3	2	—	0	—	3	0	1	0	0	0
L_4	2	—	1	—	3	0	1	1	0	0
L_5	3	—	—	0	2	0	0	0	1	0
L_6	3	—	—	1	1	0	0	0	1	1

(a)

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	—	—	1	0	0	0	0	0	0	0
L_2	1	0	0	1	—	—	2	0	1	1	0	0	0	0
L_3	2	0	1	—	0	—	3	1	1	0	1	0	0	0
L_4	2	0	1	—	1	—	3	1	1	0	1	1	0	0
L_5	3	1	1	—	—	0	2	0	1	0	0	0	1	0
L_6	3	1	1	—	—	1	1	0	0	0	0	0	1	1

(b)

Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	—	—	1	0	0	0	0	0	0	0
L_2	1	0	0	1	—	—	2	0	1	1	0	0	0	0
L_3	2	0	1	—	0	—	3	1	1	0	1	0	0	0
L_4	2	0	1	—	1	—	3	1	1	0	1	1	0	0
L_5	3	1	1	—	—	0	2	0	1	0	0	0	1	0
L_6	3	1	1	—	—	1	1	0	0	0	0	0	1	1

(b)

choose D flip flops so the Excitation table is the same

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	—	—	1	0	0	0	0	0	0	0
L_2	1	0	0	1	—	—	2	0	1	1	0	0	0	0
L_3	2	0	1	—	0	—	3	1	1	0	1	0	0	0
L_4	2	0	1	—	1	—	3	1	1	0	1	1	0	0
L_5	3	1	1	—	—	0	2	0	1	0	0	0	1	0
L_6	3	1	1	—	—	1	1	0	0	0	0	0	1	1

Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	–	–	1	0	0	0	0	0	0	0
L_2	1	0	0	1	–	–	2	0	1	1	0	0	0	0
L_3	2	0	1	–	0	–	3	1	1	0	1	0	0	0
L_4	2	0	1	–	1	–	3	1	1	0	1	1	0	0
L_5	3	1	1	–	–	0	2	0	1	0	0	0	1	0
L_6	3	1	1	–	–	1	1	0	0	0	0	0	1	1

given the excitation table, build the circuit

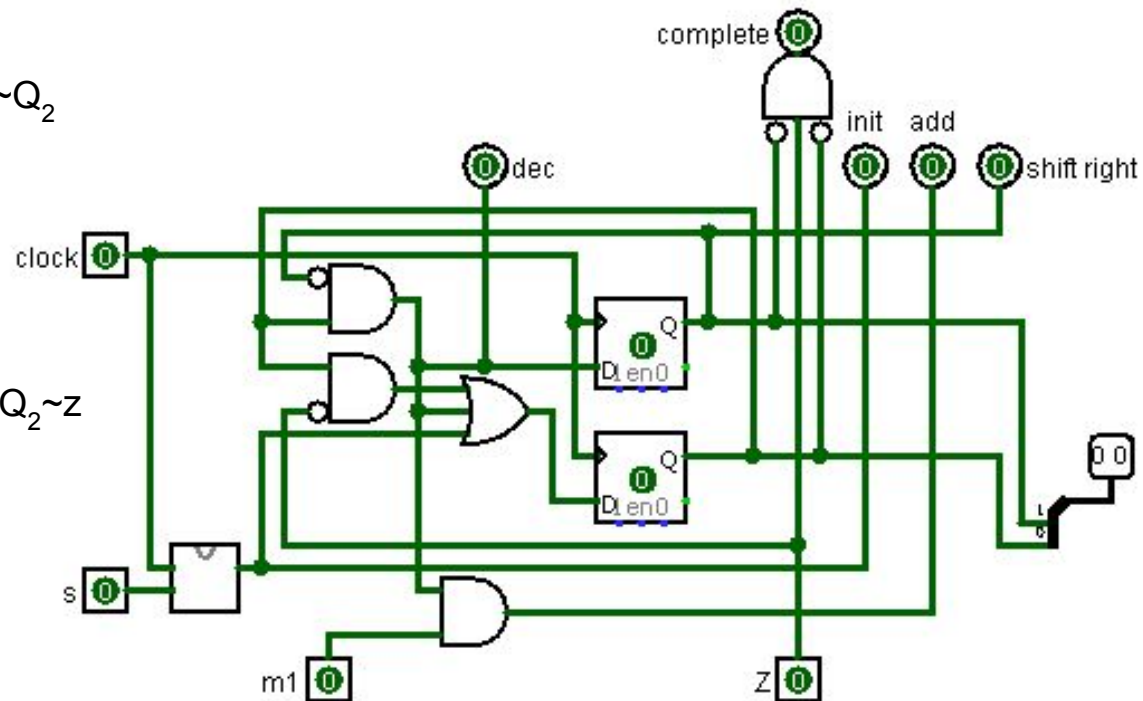


Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	—	—	1	0	0	0	0	0	0	0
L_2	1	0	0	1	—	—	2	0	1	1	0	0	0	0
L_3	2	0	1	—	0	—	3	1	1	0	1	0	0	0
L_4	2	0	1	—	1	—	3	1	1	0	1	1	0	0
L_5	3	1	1	—	—	0	2	0	1	0	0	0	1	0
L_6	3	1	1	—	—	1	1	0	0	0	0	0	1	1

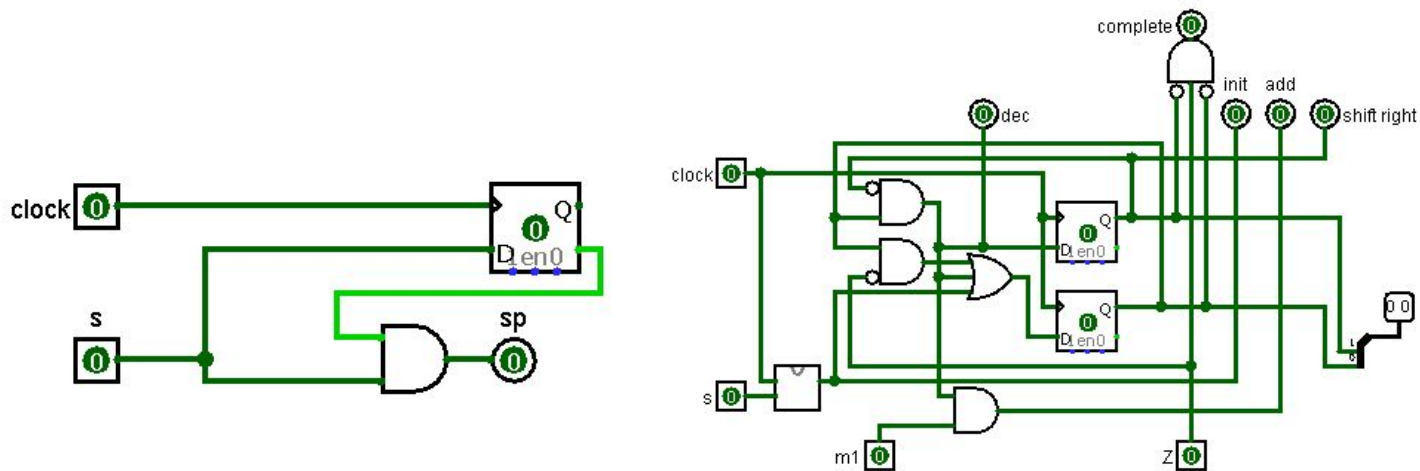
$\text{dec} = \sim Q_1 Q_2$
 $\text{complete} = z \sim Q_1 \sim Q_2$
 $\text{init} = s \text{ (modified)}$
 $\text{add} = m1 \sim Q_1 Q_2$

$\text{shift right} = Q_1$
 $d1 = \sim Q_1 Q_2$
 $d2 = s + \sim Q_1 Q_2 + Q_2 \sim Z$



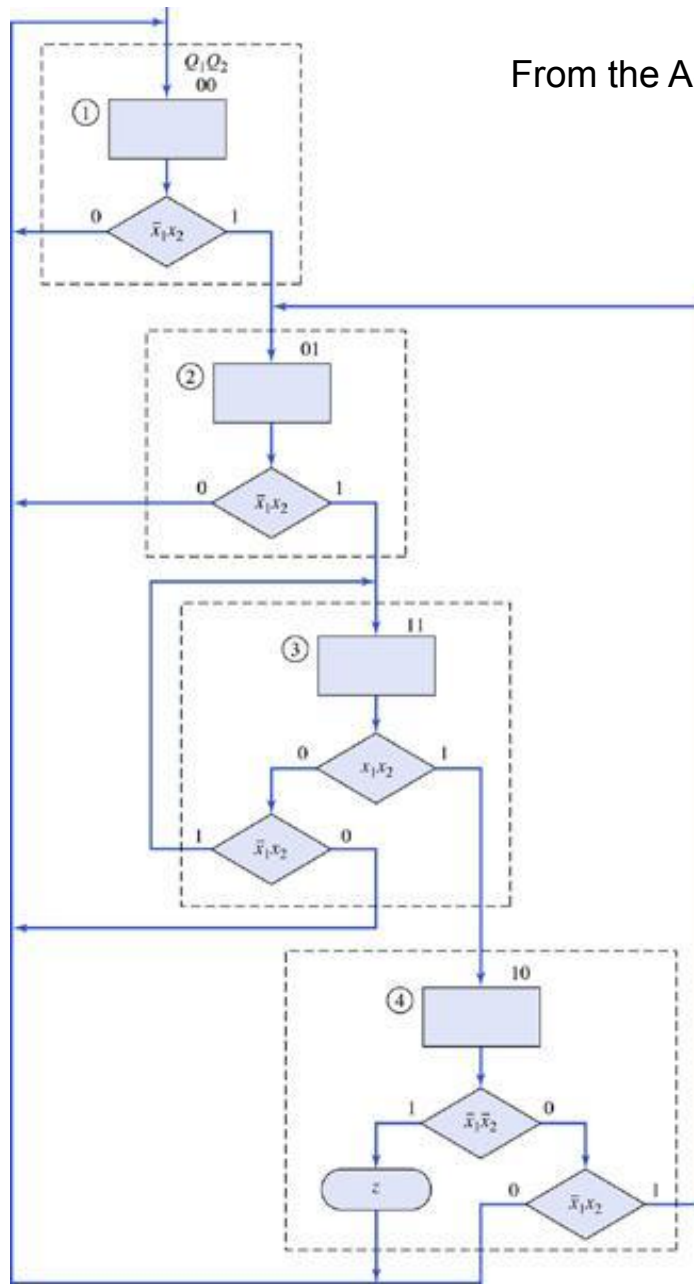
Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs			Next state			Outputs				
	Sym	Q_1	Q_2	S	M_1	Z	Sym	Q_1^+	Q_2^+	INIT	DECREM	ADD	SR	COMPLETE
L_1	1	0	0	0	—	—	1	0	0	0	0	0	0	0
L_2	1	0	0	1	—	—	2	0	1	1	0	0	0	0
L_3	2	0	1	—	0	—	3	1	1	0	1	0	0	0
L_4	2	0	1	—	1	—	3	1	1	0	1	1	0	0
L_5	3	1	1	—	—	0	2	0	1	0	0	0	1	0
L_6	3	1	1	—	—	1	1	0	0	0	0	0	1	1

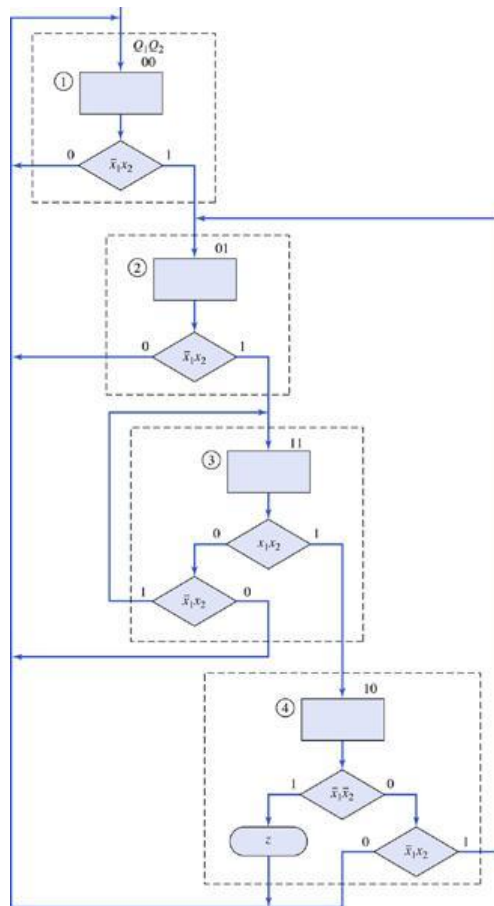


Chapter 8 Algorithmic State Machines

From the ASM, draw Link/DataPath Table (State Table)



Chapter 8 Algorithmic State Machines



Link path	Present state	Inputs		Next state	Output z
		x_1	x_2		
L_1	1	1	—	1	0
	1	—	0	1	0
L_2	1	0	1	2	0
L_3	2	1	—	1	0
	2	—	0	1	0
L_4	2	0	1	3	0
L_5	3	0	1	3	0
L_6	3	—	0	1	0
L_7	3	1	1	4	0
L_8	4	1	—	1	0
L_9	4	0	1	2	0
L_{10}	4	0	0	1	1

Chapter 8 Algorithmic State Machines



Link path	Present state	Inputs		Next state	Output z
		x_1	x_2		
L_1	1	1	—	1	0
	1	—	0	1	0
L_2	1	0	1	2	0
L_3	2	1	—	1	0
	2	—	0	1	0
L_4	2	0	1	3	0
L_5	3	0	1	3	0
L_6	3	—	0	1	0
L_7	3	1	1	4	0
L_8	4	1	—	1	0
L_9	4	0	1	2	0
L_{10}	4	0	0	1	1

from the Link/DataPath Table draw Transition Table

Chapter 8 Algorithmic State Machines

Link path	Present state	Inputs		Next state	Output z
		x_1	x_2		
L_1	1	1	—	1	0
	1	—	0	1	0
L_2	1	0	1	2	0
L_3	2	1	—	1	0
	2	—	0	1	0
L_4	2	0	1	3	0
L_5	3	0	1	3	0
L_6	3	—	0	1	0
L_7	3	1	1	4	0
L_8	4	1	—	1	0
L_9	4	0	1	2	0
L_{10}	4	0	0	1	1

(a)

Link path	Present state			Inputs		Next state			Output z
	Sym	Q_1	Q_2	x_1	x_2	Sym	Q_1^+	Q_2^+	
L_1	1	0	0	1	—	1	0	0	0
	1	0	0	—	0	1	0	0	0
L_2	1	0	0	0	1	2	0	1	0
L_3	2	0	1	1	—	1	0	0	0
	2	0	1	—	0	1	0	0	0
L_4	2	0	1	0	1	3	1	1	0
L_5	3	1	1	0	1	3	1	1	0
L_6	3	1	1	—	0	1	0	0	0
L_7	3	1	1	1	1	4	1	0	0
L_8	4	1	0	1	—	1	0	0	0
L_9	4	1	0	0	1	2	0	1	0
L_{10}	4	1	0	0	0	1	0	0	1

(b)

Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs		Next state			Output
	Sym	Q_1	Q_2	x_1	x_2	Sym	Q_1^+	Q_2^+	z
L_1	1	0	0	1	—	1	0	0	0
	1	0	0	—	0	1	0	0	0
L_2	1	0	0	0	1	2	0	1	0
L_3	2	0	1	1	—	1	0	0	0
	2	0	1	—	0	1	0	0	0
L_4	2	0	1	0	1	3	1	1	0
L_5	3	1	1	0	1	3	1	1	0
L_6	3	1	1	—	0	1	0	0	0
L_7	3	1	1	1	1	4	1	0	0
L_8	4	1	0	1	—	1	0	0	0
L_9	4	1	0	0	1	2	0	1	0
L_{10}	4	1	0	0	0	1	0	0	1

From Transition Table, Draw D flip flop Excitation Table

Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs		Next state			Output z
	Sym	Q_1	Q_2	x_1	x_2	Sym	Q_1^+	Q_2^+	
L_1	1	0	0	1	—	1	0	0	0
	1	0	0	—	0	1	0	0	0
L_2	1	0	0	0	1	2	0	1	0
L_3	2	0	1	1	—	1	0	0	0
	2	0	1	—	0	1	0	0	0
L_4	2	0	1	0	1	3	1	1	0
L_5	3	1	1	0	1	3	1	1	0
L_6	3	1	1	—	0	1	0	0	0
L_7	3	1	1	1	1	4	1	0	0
L_8	4	1	0	1	—	1	0	0	0
L_9	4	1	0	0	1	2	0	1	0
L_{10}	4	1	0	0	0	1	0	0	1

For D flip Flop Excitation is same as Transition

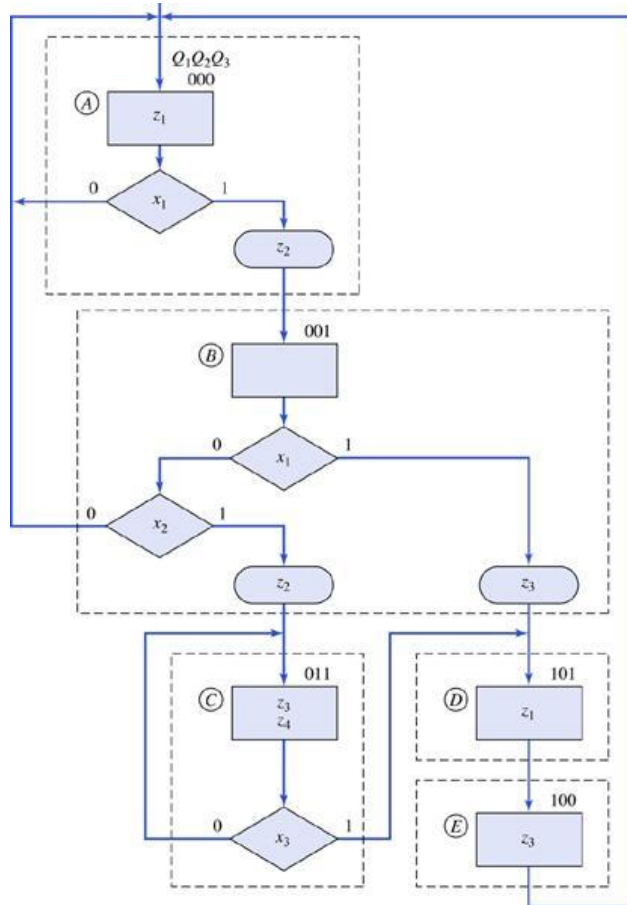
Link path	Present state			Inputs		Next state			Output z
	Sym	Q_1	Q_2	x_1	x_2	Sym	Q_1^+	Q_2^+	
L_1	1	0	0	1	—	1	0	0	0
	1	0	0	—	0	1	0	0	0
L_2	1	0	0	0	1	2	0	1	0
L_3	2	0	1	1	—	1	0	0	0
	2	0	1	—	0	1	0	0	0
L_4	2	0	1	0	1	3	1	1	0
L_5	3	1	1	0	1	3	1	1	0
L_6	3	1	1	—	0	1	0	0	0
L_7	3	1	1	1	1	4	1	0	0
L_8	4	1	0	1	—	1	0	0	0
L_9	4	1	0	0	1	2	0	1	0
L_{10}	4	1	0	0	0	1	0	0	1

Chapter 8 Algorithmic State Machines

Link path	Present state			Inputs		Next state			Output z
	Sym	Q_1	Q_2	x_1	x_2	Sym	Q_1^+	Q_2^+	
L_1	1	0	0	1	–	1	0	0	0
	1	0	0	–	0	1	0	0	0
L_2	1	0	0	0	1	2	0	1	0
L_3	2	0	1	1	–	1	0	0	0
	2	0	1	–	0	1	0	0	0
L_4	2	0	1	0	1	3	1	1	0
L_5	3	1	1	0	1	3	1	1	0
L_6	3	1	1	–	0	1	0	0	0
L_7	3	1	1	1	1	4	1	0	0
L_8	4	1	0	1	–	1	0	0	0
L_9	4	1	0	0	1	2	0	1	0
L_{10}	4	1	0	0	0	1	0	0	1

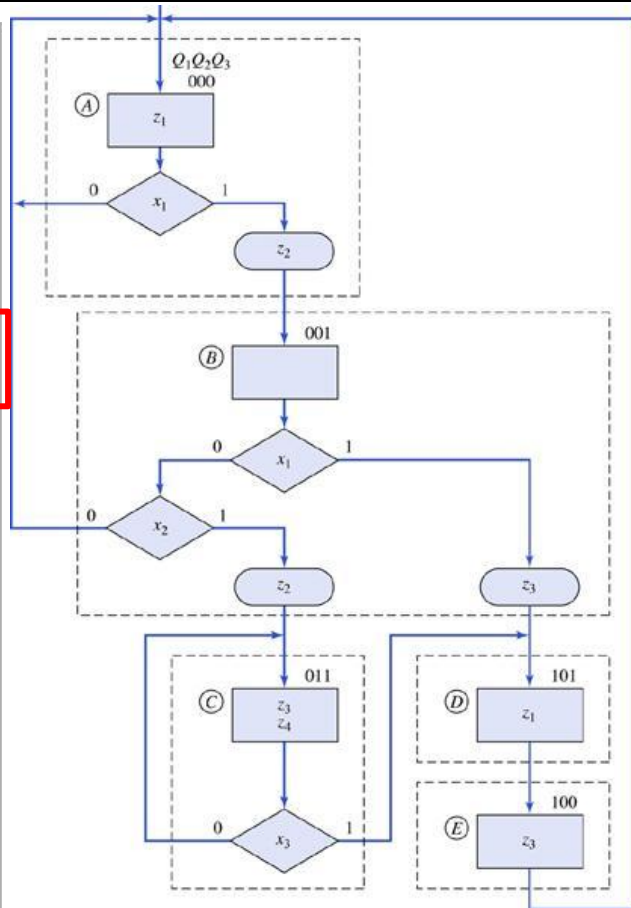
From the Excitation Table, Find the Equations

Chapter 8 Algorithmic State Machines



given ASM, draw ASM Link Table .. or
Data Path table .. like State Table

Chapter 8 Algorithmic State Machines



ASM Link/DataPath Table

Link path	Present state	Inputs			Next state	Outputs			
		x_1	x_2	x_3		z_1	z_2	z_3	z_4
L_1	A	0	—	—	A	1	0	0	0
L_2	A	1	—	—	B	1	1	0	0
L_3	B	0	0	—	A	0	0	0	0
L_4	B	0	1	—	C	0	1	0	0
L_5	B	1	—	—	D	0	0	1	0
L_6	C	—	—	0	C	0	0	1	1
L_7	C	—	—	1	D	0	0	1	1
L_8	D	—	—	—	E	1	0	0	0
L_9	E	—	—	—	A	0	0	1	0

Chapter 8 Algorithmic State Machines

No Implicant Table .. not trying to Link Path/Data Path table.

Link path	Present state	Inputs			Next state	Outputs			
		x_1	x_2	x_3		z_1	z_2	z_3	z_4
L_1	A	0	–	–	A	1	0	0	0
L_2	A	1	–	–	B	1	1	0	0
L_3	B	0	0	–	A	0	0	0	0
L_4	B	0	1	–	C	0	1	0	0
L_5	B	1	–	–	D	0	0	1	0
L_6	C	–	–	0	C	0	0	1	1
L_7	C	–	–	1	D	0	0	1	1
L_8	D	–	–	–	E	1	0	0	0
L_9	E	–	–	–	A	0	0	1	0

draw Transition Table from Link/Data Path Table

Chapter 8 Algorithmic State Machines

Transition Table .. replace states with flip flop values .. one bit changes between states

Link path	Present state	Inputs			Next state	Outputs			
		x_1	x_2	x_3		z_1	z_2	z_3	z_4
L_1	A	0	–	–	A	1	0	0	0
L_2	A	1	–	–	B	1	1	0	0
L_3	B	0	0	–	A	0	0	0	0
L_4	B	0	1	–	C	0	1	0	0
L_5	B	1	–	–	D	0	0	1	0
L_6	C	–	–	0	C	0	0	1	1
L_7	C	–	–	1	D	0	0	1	1
L_8	D	–	–	–	E	1	0	0	0
L_9	E	–	–	–	A	0	0	1	0

State Locus Calculation

		Q_2Q_3			
		00	01	11	10
Q_1	0	A	B	C	–
	1	E	D	–	–

State transition A \longrightarrow B = 000 \longrightarrow 001 1 bit change
 State transition B \longrightarrow A = 001 \longrightarrow 000 1 bit change
 State transition B \longrightarrow C = 001 \longrightarrow 011 1 bit change
 State transition B \longrightarrow D = 001 \longrightarrow 101 1 bit change
 State transition C \longrightarrow D = 011 \longrightarrow 101 2 bit changes
 State transition D \longrightarrow E = 101 \longrightarrow 100 1 bit change
 State transition E \longrightarrow A = 100 \longrightarrow 000 1 bit change

Total = 8 = state locus

Chapter 8 Algorithmic State Machines

Table 8.1 ASM tables for Fig. 8.21. (a) ASM transition table. (b) Assigned ASM transition table

Link path	Present state	Inputs			Next state	Outputs			
		x_1	x_2	x_3		z_1	z_2	z_3	z_4
L_1	A	0	–	–	A	1	0	0	0
L_2	A	1	–	–	B	1	1	0	0
L_3	B	0	0	–	A	0	0	0	0
L_4	B	0	1	–	C	0	1	0	0
L_5	B	1	–	–	D	0	0	1	0
L_6	C	–	–	0	C	0	0	1	1
L_7	C	–	–	1	D	0	0	1	1
L_8	D	–	–	–	E	1	0	0	0
L_9	E	–	–	–	A	0	0	1	0

		Q_2Q_3			
		00	01	11	10
Q_1	0	A	B	C	–
	1	E	D	–	–

draw Transition Table from Link/Data Path Table

Chapter 8 Algorithmic State Machines

Table 8.1 ASM tables for Fig. 8.21. (a) ASM transition table. (b) Assigned ASM transition table

Link path	Present state	Inputs			Next state	Outputs			
		x_1	x_2	x_3		z_1	z_2	z_3	z_4
L_1	A	0	–	–	A	1	0	0	0
L_2	A	1	–	–	B	1	1	0	0
L_3	B	0	0	–	A	0	0	0	0
L_4	B	0	1	–	C	0	1	0	0
L_5	B	1	–	–	D	0	0	1	0
L_6	C	–	–	0	C	0	0	1	1
L_7	C	–	–	1	D	0	0	1	1
L_8	D	–	–	–	E	1	0	0	0
L_9	E	–	–	–	A	0	0	1	0

(a)

		Q_2Q_3			
		00	01	11	10
Q_1	0	A	B	C	–
	1	E	D	–	–

Link path	Present state				Inputs			Next state				Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	–	–	A	0	0	0	1	0	0	0
L_2	A	0	0	0	1	–	–	B	0	0	1	1	1	0	0
L_3	B	0	0	1	0	0	–	A	0	0	0	0	0	0	0
L_4	B	0	0	1	0	1	–	C	0	1	1	0	1	0	0
L_5	B	0	0	1	1	–	–	D	1	0	1	0	0	1	0
L_6	C	0	1	1	–	–	0	C	0	1	1	0	0	1	1
L_7	C	0	1	1	–	–	1	D	1	0	1	0	0	1	1
L_8	D	1	0	1	–	–	–	E	1	0	0	1	0	0	0
L_9	E	1	0	0	–	–	–	A	0	0	0	0	0	1	0

(b)

Chapter 8 Algorithmic State Machines

Link path	Sym	Present state			Inputs			Sym	Next state			Outputs			
		Q_1	Q_2	Q_3	x_1	x_2	x_3		Q_1^+	Q_2^+	Q_3^+	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	–	–	A	0	0	0	1	0	0	0
L_2	A	0	0	0	1	–	–	B	0	0	1	1	1	0	0
L_3	B	0	0	1	0	0	–	A	0	0	0	0	0	0	0
L_4	B	0	0	1	0	1	–	C	0	1	1	0	1	0	0
L_5	B	0	0	1	1	–	–	D	1	0	1	0	0	1	0
L_6	C	0	1	1	–	–	0	C	0	1	1	0	0	1	1
L_7	C	0	1	1	–	–	1	D	1	0	1	0	0	1	1
L_8	D	1	0	1	–	–	–	E	1	0	0	1	0	0	0
L_9	E	1	0	0	–	–	–	A	0	0	0	0	0	1	0

from Transition Table, draw JK Excitation Table

Chapter 8 Algorithmic State Machines

Link path	Present state				Inputs			Next state				Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	–	–	A	0	0	0	1	0	0	0
L_2	A	0	0	0	1	–	–	B	0	0	1	1	1	0	0
L_3	B	0	0	1	0	0	–	A	0	0	0	0	0	0	0
L_4	B	0	0	1	0	1	–	C	0	1	1	0	1	0	0
L_5	B	0	0	1	1	–	–	D	1	0	1	0	0	1	0
L_6	C	0	1	1	–	–	0	C	0	1	1	0	0	1	1
L_7	C	0	1	1	–	–	1	D	1	0	1	0	0	1	1
L_8	D	1	0	1	–	–	–	E	1	0	0	1	0	0	0
L_9	E	1	0	0	–	–	–	A	0	0	0	0	0	1	0

Table 8.5 ASM excitation table for Table 8.1b

Link path	Present state				Inputs			Next state				Excitations						Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	J_1	K_1	J_2	K_2	J_3	K_3	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	–	–	A	0	0	0	0	–	0	–	0	–	1	0	0	0
L_2	A	0	0	0	1	–	–	B	0	0	1	0	–	0	–	1	–	1	1	0	0
L_3	B	0	0	1	0	0	–	A	0	0	0	0	–	0	–	–	1	0	0	0	0
L_4	B	0	0	1	0	1	–	C	0	1	1	0	–	1	–	–	0	0	1	0	0
L_5	B	0	0	1	1	–	–	D	1	0	1	1	–	0	–	–	0	0	0	1	0
L_6	C	0	1	1	–	–	0	C	0	1	1	0	–	–	0	–	0	0	0	1	1
L_7	C	0	1	1	–	–	1	D	1	0	1	1	–	–	1	–	0	0	0	1	1
L_8	D	1	0	1	–	–	–	E	1	0	0	–	0	0	–	–	1	1	0	0	0
L_9	E	1	0	0	–	–	–	A	0	0	0	–	1	0	–	0	–	0	0	1	0

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Table 8.5 ASM excitation table for Table 8.1b

Link path	Present state				Inputs			Next state				Excitations						Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	J_1	K_1	J_2	K_2	J_3	K_3	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	—	—	A	0	0	0	0	—	0	—	0	—	1	0	0	0
L_2	A	0	0	0	1	—	—	B	0	0	1	0	—	0	—	1	—	1	1	0	0
L_3	B	0	0	1	0	0	—	A	0	0	0	0	—	0	—	—	1	0	0	0	0
L_4	B	0	0	1	0	1	—	C	0	1	1	0	—	1	—	—	0	0	1	0	0
L_5	B	0	0	1	1	—	—	D	1	0	1	1	—	0	—	—	0	0	0	1	0
L_6	C	0	1	1	—	—	0	C	0	1	1	0	—	—	0	—	0	0	0	1	1
L_7	C	0	1	1	—	—	1	D	1	0	1	1	—	—	1	—	0	0	0	1	1
L_8	D	1	0	1	—	—	—	E	1	0	0	—	0	0	—	—	1	1	0	0	0
L_9	E	1	0	0	—	—	—	A	0	0	0	—	1	0	—	0	—	0	0	1	0

From the Excitation Table, find the equations

Chapter 8 Algorithmic State Machines

Table 8.5 ASM excitation table for Table 8.1b

Link path	Present state				Inputs			Next state				Excitations						Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	J_1	K_1	J_2	K_2	J_3	K_3	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	—	—	A	0	0	0	0	—	0	—	0	—	1	0	0	0
L_2	A	0	0	0	1	—	—	B	0	0	1	0	—	0	—	1	—	1	1	0	0
L_3	B	0	0	1	0	0	—	A	0	0	0	0	—	0	—	—	1	0	0	0	0
L_4	B	0	0	1	0	1	—	C	0	1	1	0	—	1	—	—	0	0	1	0	0
L_5	B	0	0	1	1	—	—	D	1	0	1	1	—	0	—	—	0	0	0	1	0
L_6	C	0	1	1	—	—	0	C	0	1	1	0	—	—	0	—	0	0	0	1	1
L_7	C	0	1	1	—	—	1	D	1	0	1	1	—	—	1	—	0	0	0	1	1
L_8	D	1	0	1	—	—	—	E	1	0	0	—	0	0	—	—	1	1	0	0	0
L_9	E	1	0	0	—	—	—	A	0	0	0	—	1	0	—	0	—	0	0	1	0

Q_2Q_3

	00	01	11	10
0	0	x_1	x_3	-
1	-	-	-	-

$$J_1 = x_1\bar{Q}_2Q_3 + x_3Q_2$$

Q_2Q_3

	00	01	11	10
0	0	\bar{x}_1x_2	-	-
1	0	0	-	-

$$J_2 = \bar{x}_1x_2\bar{Q}_1Q_3$$

Q_2Q_3

	00	01	11	10
0	x_1	-	-	-
1	0	-	-	-

$$J_3 = x_1\bar{Q}_1$$

Q_2Q_3

	00	01	11	10
0	-	-	-	-
1	1	0	-	-

$$K_1 = \bar{Q}_3$$

Q_2Q_3

	00	01	11	10
0	-	-	x_3	-
1	-	-	-	-

$$K_2 = x_3$$

Q_2Q_3

	00	01	11	10
0	-	$\bar{x}_1\bar{x}_2$	0	-
1	-	1	-	-

$$K_3 = \bar{x}_1\bar{x}_2\bar{Q}_2 + Q_1$$

Chapter 8 Algorithmic State Machines

Link path	Present state				Inputs			Next state				Outputs			
	Sym	Q_1	Q_2	Q_3	x_1	x_2	x_3	Sym	Q_1^+	Q_2^+	Q_3^+	z_1	z_2	z_3	z_4
L_1	A	0	0	0	0	-	-	A	0	0	0	1	0	0	0
L_2	A	0	0	0	1	-	-	B	0	0	1	1	1	0	0
L_3	B	0	0	1	0	0	-	A	0	0	0	0	0	0	0
L_4	B	0	0	1	0	1	-	C	0	1	1	0	1	0	0
L_5	B	0	0	1	1	-	-	D	1	0	1	0	0	1	0
L_6	C	0	1	1	-	-	0	C	0	1	1	0	0	1	1
L_7	C	0	1	1	-	-	1	D	1	0	1	0	0	1	1
L_8	D	1	0	1	-	-	-	E	1	0	0	1	0	0	0
L_9	E	1	0	0	-	-	-	A	0	0	0	0	0	1	0



Chapter 8 Algorithmic State Machines

Link path	Sym	Present state				Inputs			Sym	Next state				Outputs			
		Q_1	Q_2	Q_3		x_1	x_2	x_3		Q_1^+	Q_2^+	Q_3^+		z_1	z_2	z_3	z_4
L_1	A	0	0	0		0	-	-	A	0	0	0		1	0	0	0
L_2	A	0	0	0		1	-	-	B	0	0	1		1	1	0	0
L_3	B	0	0	1		0	0	-	A	0	0	0		0	0	0	0
L_4	B	0	0	1		0	1	-	C	0	1	1		0	1	0	0
L_5	B	0	0	1		1	-	-	D	1	0	1		0	0	1	0
L_6	C	0	1	1		-	-	0	C	0	1	1		0	0	1	1
L_7	C	0	1	1		-	-	1	D	1	0	1		0	0	1	1
L_8	D	1	0	1		-	-	-	E	1	0	0		1	0	0	0
L_9	E	1	0	0		-	-	-	A	0	0	0		0	0	1	0

$$Q_2Q_3$$

	00	01	11	10
0	0	x_1	x_3	-
1	0	1	-	-

$$Q_1^+ = D_1 = x_1\bar{Q}_2Q_3 + x_3Q_2 + Q_1Q_3$$

$$Q_2Q_3$$

	00	01	11	10
0	0	\bar{x}_1x_2	\bar{x}_3	-
1	0	0	-	-

$$Q_2^+ = D_2 = \bar{x}_1x_2\bar{Q}_1\bar{Q}_2Q_3 + \bar{x}_3Q_2$$

$$Q_2Q_3$$

	00	01	11	10
0	x_1	$x_1 + x_2$	1	-
1	0	0	-	-

$$Q_3^+ = D_3 = x_1\bar{Q}_1 + x_2\bar{Q}_1Q_3 + Q_2$$

$$Q_2Q_3$$

	00	01	11	10
0	1	0	0	-
1	0	1	-	-

$$z_1 = \bar{Q}_1\bar{Q}_3 + Q_1Q_3$$

$$Q_2Q_3$$

	00	01	11	10
0	x_1	\bar{x}_1x_2	0	-
1	0	0	-	-

$$z_2 = x_1\bar{Q}_1\bar{Q}_3 + \bar{x}_1x_2\bar{Q}_1\bar{Q}_2Q_3$$

$$Q_2Q_3$$

	00	01	11	10
0	0	x_1	1	-
1	1	0	-	-

$$z_3 = x_1\bar{Q}_1Q_3 + Q_2 + Q_1\bar{Q}_3$$

$$Q_2Q_3$$

	00	01	11	10
0	0	0	1	-
1	0	0	-	-

$$z_4 = Q_2$$

Chapter 8 Algorithmic State Machines

Build Using Mux

		Q_2Q_3			
		00	01	11	10
Q_1	0	0	x_1	x_3	-
	1	0	1	-	-

$$Q_1^+ = D_1$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	0	\bar{x}_1x_2	\bar{x}_3	-
	1	0	0	-	-

$$Q_2^+ = D_2$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	x_1	$x_1 + x_2$	1	-
	1	0	0	-	-

$$Q_3^+ = D_3$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	1	0	0	-
	1	0	1	-	-

$$z_1 = \bar{Q}_1\bar{Q}_3 + Q_1Q_3$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	x_1	\bar{x}_1x_2	0	-
	1	0	0	-	-

$$z_2 = x_1\bar{Q}_1\bar{Q}_3 + \bar{x}_1x_2\bar{Q}_1\bar{Q}_2Q_3$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	0	x_1	1	-
	1	1	0	-	-

$$z_3 = x_1\bar{Q}_1Q_3 + Q_2 + Q_1\bar{Q}_3$$

		Q_2Q_3			
		00	01	11	10
Q_1	0	0	0	1	-
	1	0	0	-	-

$$z_4 = Q_2$$

Chapter 8 Algorithmic State Machines

Q_2Q_3

	00	01	11	10
0	0	x_1	x_3	-
1	0	1	-	-

$Q_1^+ = D_1$

Q_2Q_3

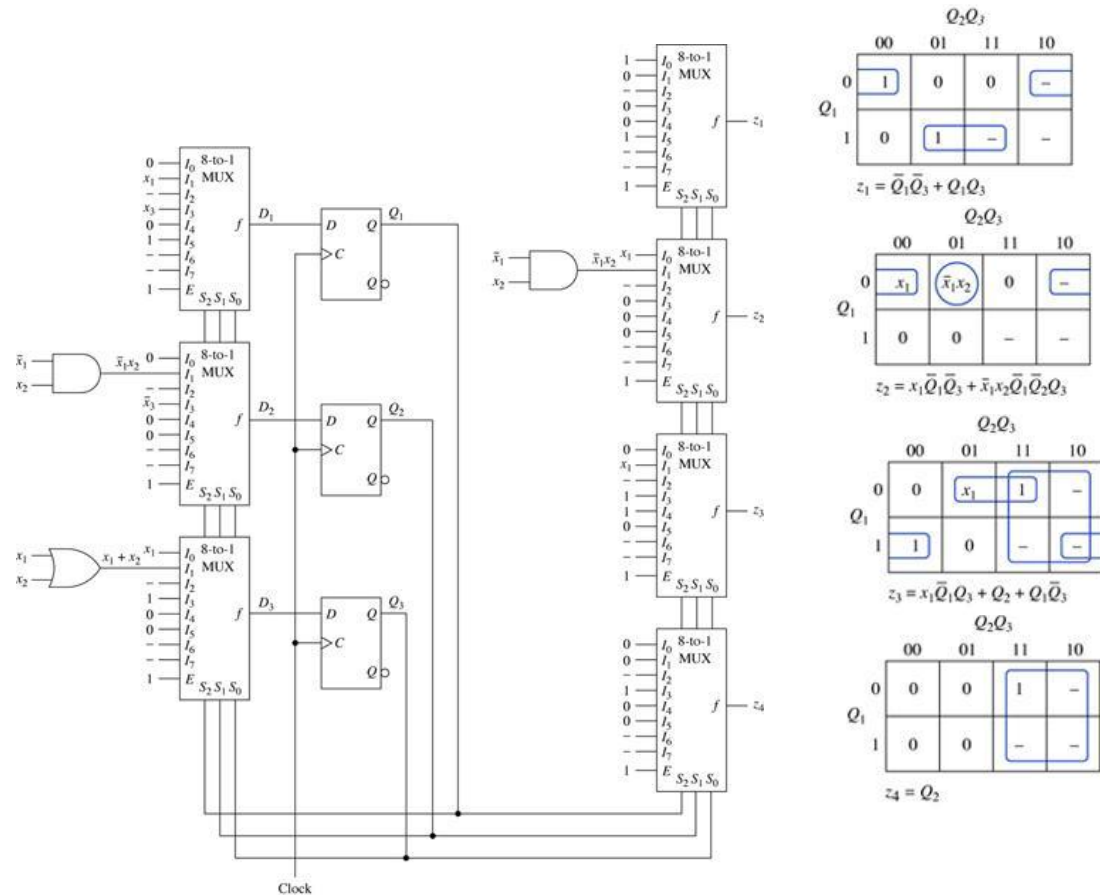
	00	01	11	10
0	0	\bar{x}_1x_2	\bar{x}_3	-
1	0	0	-	-

$Q_2^+ = D_2$

Q_2Q_3

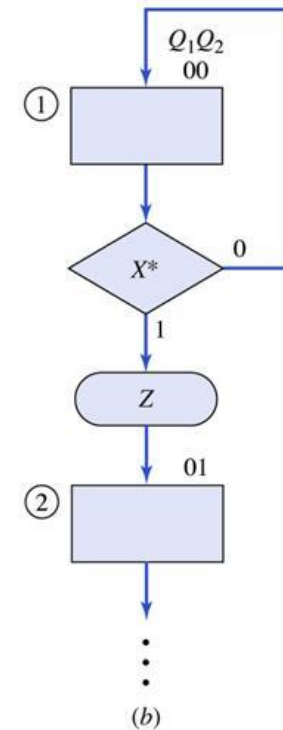
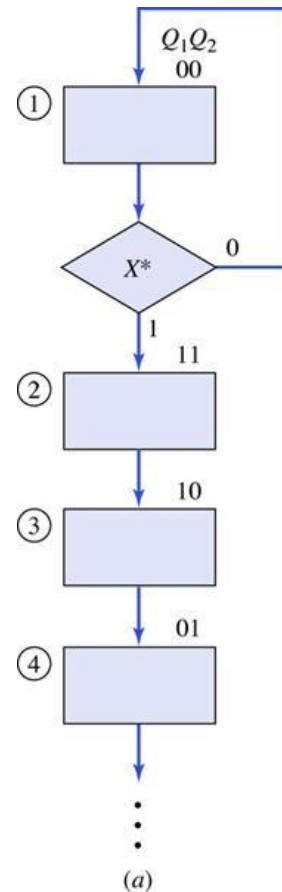
	00	01	11	10
0	x_1	$x_1 + x_2$	1	-
1	0	0	-	-

$Q_3^+ = D_3$



Chapter 8 Algorithmic State Machines

What if the input is ASYN?
What if the Input doesn't
hold through setup period
of machine clock cycle.
What if there is no Clock?
What are the problems?



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