

Sequential Circuits Design

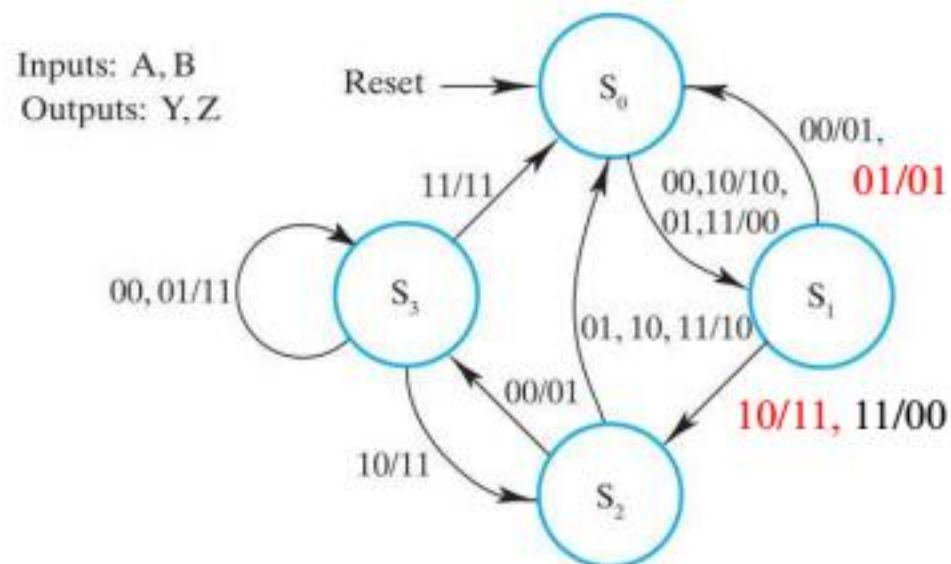
State-Machine Diagrams p.221~

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State-Machine Diagrams p.221

- 전통적인 상태도 : 큰 설계에 적용하기에 비효율적이다.
 - 입력변수와 출력변수를 모두 열거해야 한다.
 - 간소하고 효율적인 상태다이어그램 표현이 필요하다.



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State-Machine Diagrams

p.221

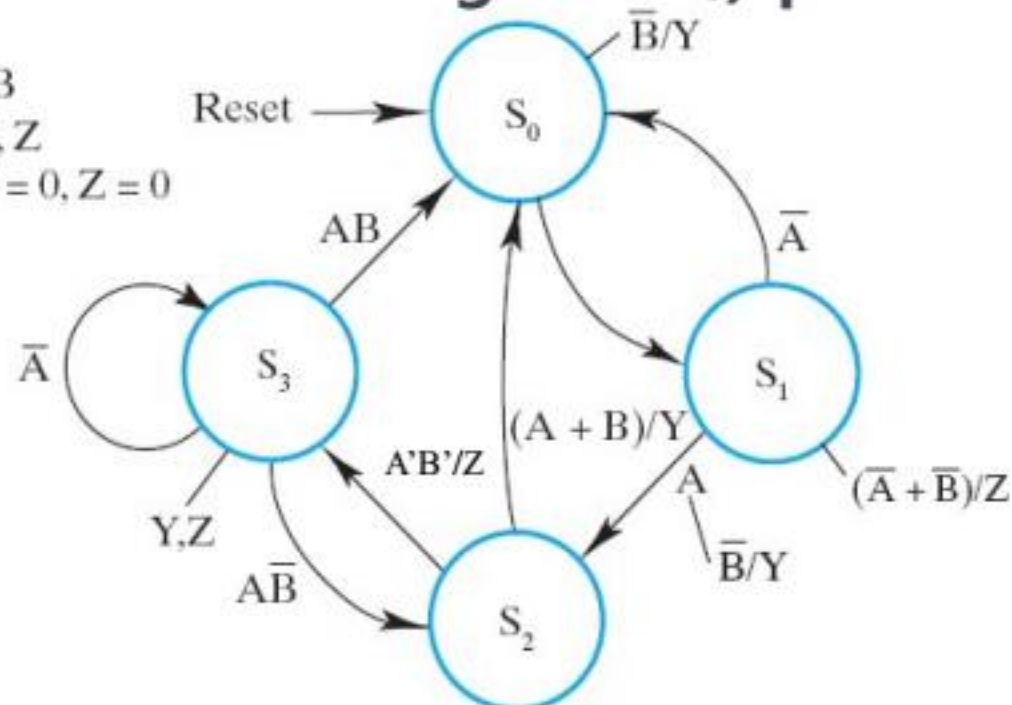
- 전통적인 상태도 : 큰 설계에 적용하기에 비효율적이다.
 - 입력변수와 출력변수를 모두 열거해야 한다.
 - 간소하고 효율적인 상태다이어그램 표현이 필요하다.
- State-Machine Diagram
 - 조건 : 입력변수들을 부울 수식으로 표현
 - TC (Transition condition 변이조건): 1이면 변이가 일어난다
 - OC(output condition 출력조건) : 1이면 출력한다.



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State-Machine Diagram 예) p.222

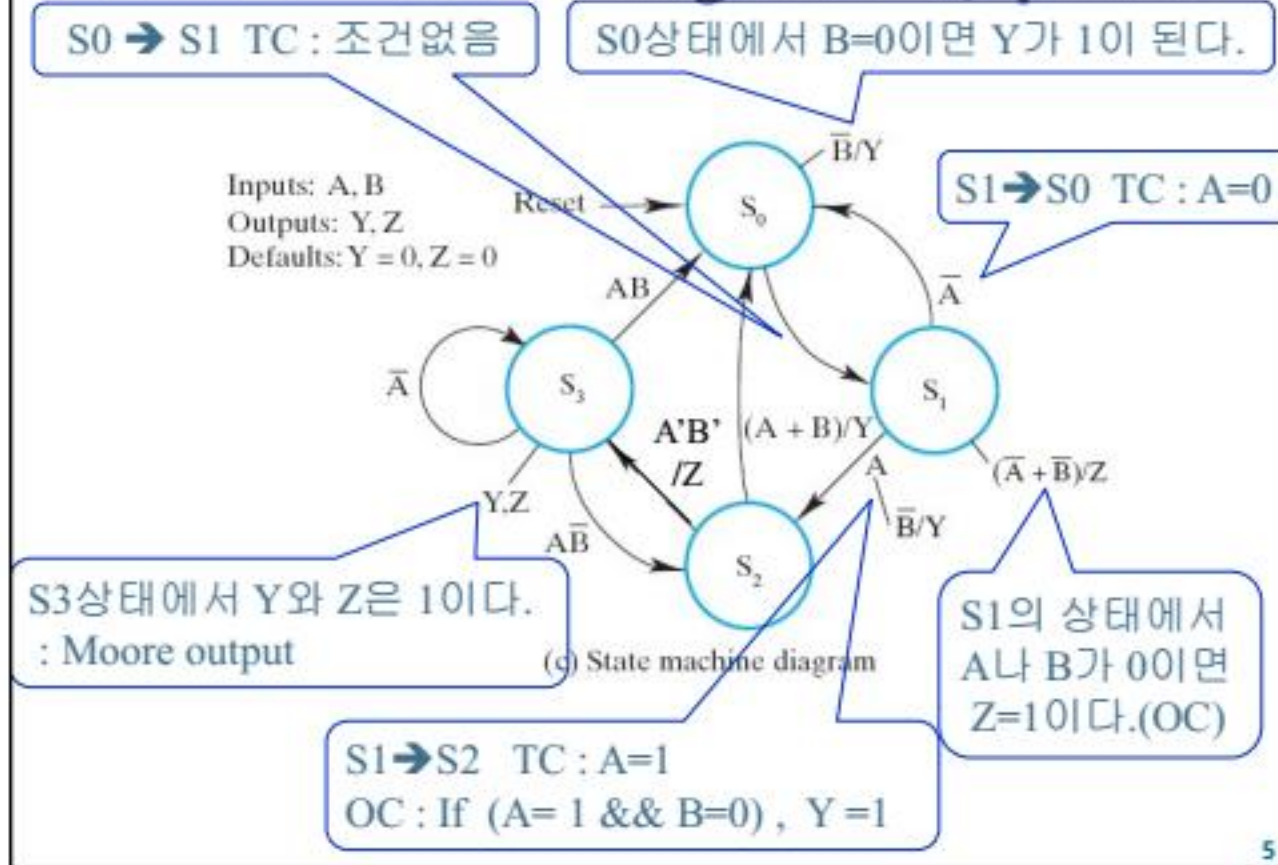
Inputs: A, B
Outputs: Y, Z
Defaults: Y = 0, Z = 0



(c) State machine diagram

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State-Machine Diagram 예) p.222



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Constraints of State-Machine Diagram p. 224

■ Constraint 1

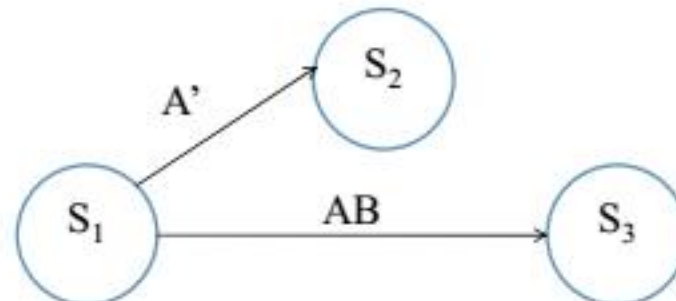
-주어진 상태로부터의 전이 조건 T1 T2 T3는 상호배타적이어야 한다.

$$T1 \cdot T2 = 0, T1 \cdot T3 = 0, T2 \cdot T3 = 0 \quad (\text{중복되는 조건이 있는가?})$$

■ Constraint 2

-주어진 상태로부터의 전이 조건 T1 T2 T3은 모든 조합을 가져야 한다.

$$T1 + T2 + T3 = 1 \quad (\text{모든 조건을 다 고려하고 있는가?})$$



$$A' \cdot AB = 0 ?$$

$$A' + AB = 1 ?$$

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Constraints of State-Machine Diagram p. 222,224

■ Constraint 1

- $T1 \cdot T2=0, T1 \cdot T3=0, T2 \cdot T3=0$ (중복되는 조건이 있는가?)

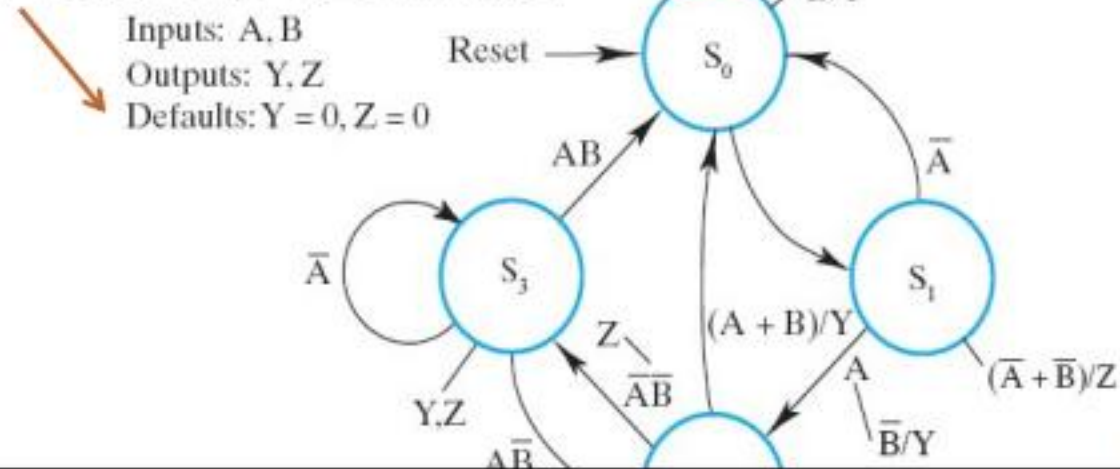
■ Constraint 2

- $T1 + T2 + T3 = 1$ (모든 조건을 다 고려하고 있는가?)

★필요에 따라 default로 이해하기도 한다.

■ 출력 조건에 대해서는 위 제약조건 1이 적용된다.

(제약조건2:디폴트 출력이 해결)



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Constraints for TC

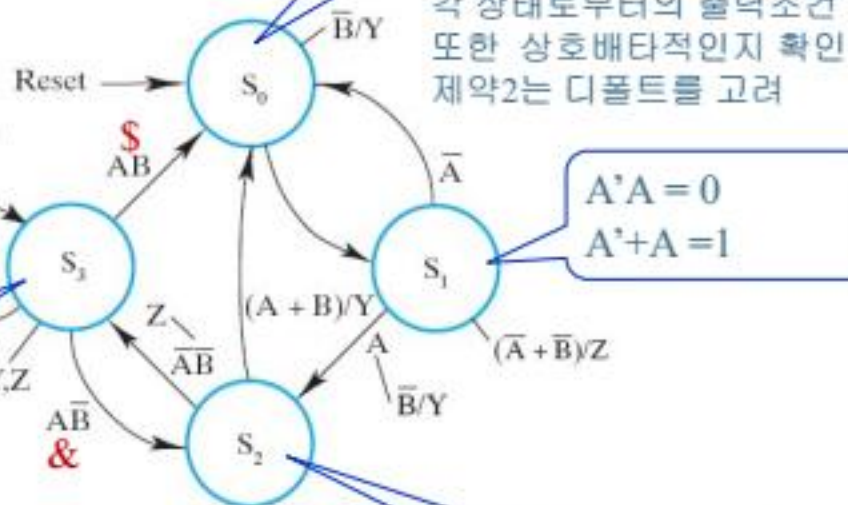
Constraints 1,2 만족

Inputs: A, B
Outputs: Y, Z
Defaults: Y = 0, Z = 0

B	
%	%
A	&
	\$

$(AB)A' = 0$
 $(AB)(AB') = 0$
 $A'(AB') = 0$

$A' + AB + AB' = 1$



(c) State machine diagram

$(A+B)(A'B') = 0$

$(A+B) + (A'B') = 1$

각 상태로부터의 출력조건 또한 상호배타적인지 확인
제약2는 디폴트를 고려

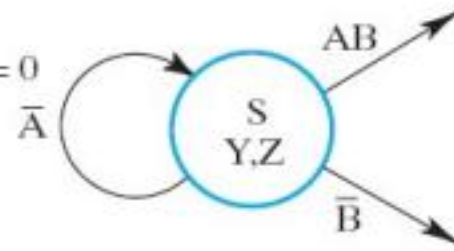
$A'A = 0$
 $A'+A = 1$

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Invalid cases for Constraints p.222 (d)(e)

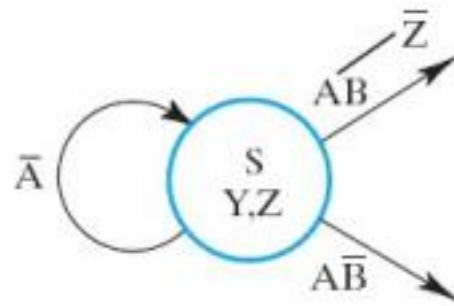
■ TC문제점?

Inputs: A, B
Outputs: Y, Z
Defaults: Y = 0, Z = 0



(d) Invalid Transition Conditions

■ OC문제점?



(e) Invalid Output Action



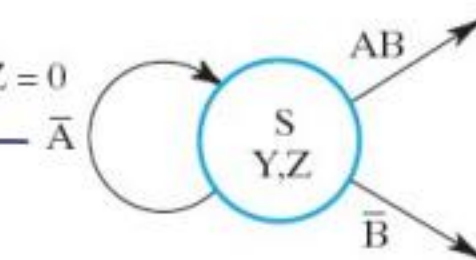
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Invalid cases for Constraints

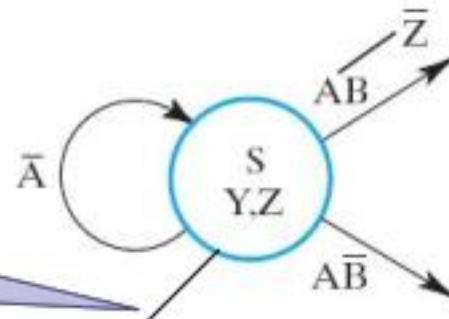
Inputs: A, B
Outputs: Y, Z
Defaults: Y = 0, Z = 0

$A' \rightarrow A'B$



(d) Invalid Transition Conditions

$Y, Z \rightarrow (A' + B')/Z$



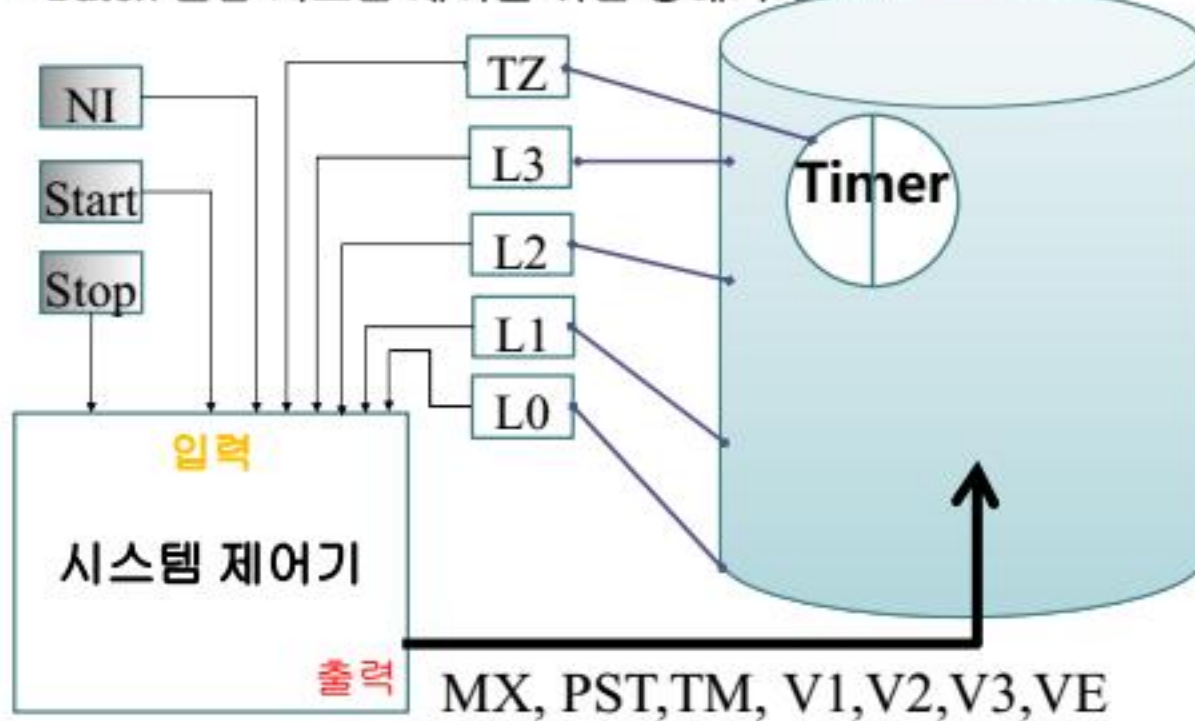
(e) Invalid Output Action

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State-Machine Diagram 응용 p.226

■ Batch 혼합 시스템 제어를 위한 상태기계설계



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State-Machine Diagram 응용' p.227

Input	Meaning for Value 1	Meaning for Value 0*
NI	Three ingredients	Two ingredients
Start	Start a batch cycle	No action
Stop	Stop an on-going batch cycle	No action
L0	Tank empty	Tank not empty
L1	Tank filled to level 1	Tank not filled to level 1
L2	Tank filled to level 2	Tank not filled to level 2
L3	Tank filled to level 3	Tank not filled to level 3
TZ	Timer at value 0	Timer not at value 0
Output	Meaning for Value 1	Meaning for Value 0
MX	Mixer on	Mixer off
PST	Load timer with value from D	No action
TM	Timer on	Timer off
V1	Valve open for ingredient 1	Valve closed for ingredient 1
V2	Valve open for ingredient 2	Valve closed for ingredient 2
V3	Valve open for ingredient 3	Valve closed for ingredient 3
VE	Output valve open	Output valve closed

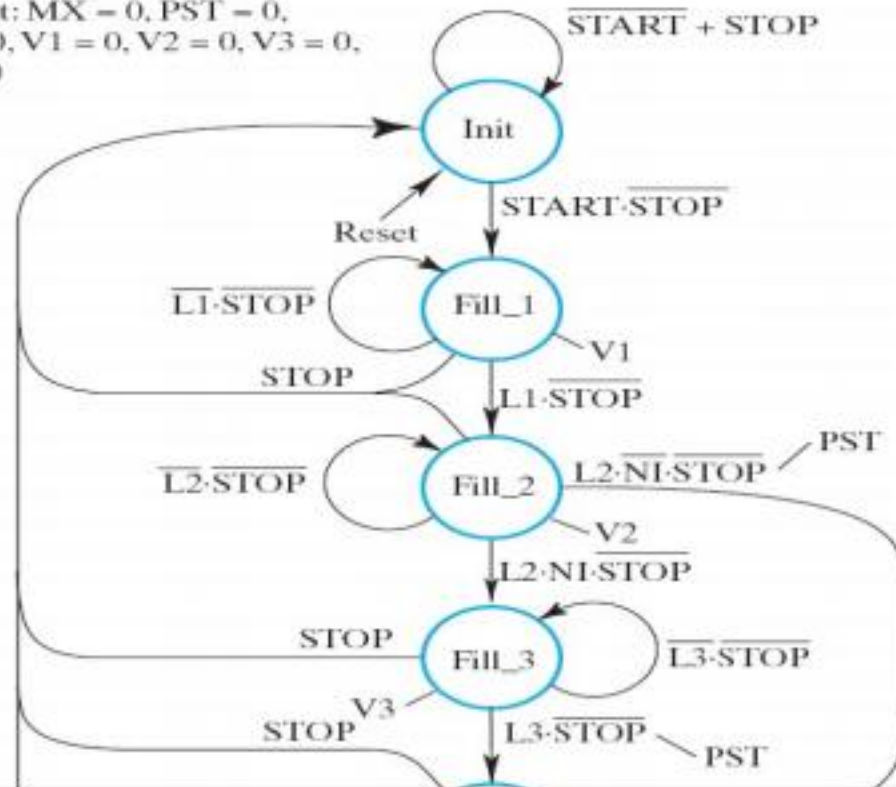
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State-Machine Diagram 응용 p.229

■ Batch 혼합 시스템 제어를 위한 상태기계설계

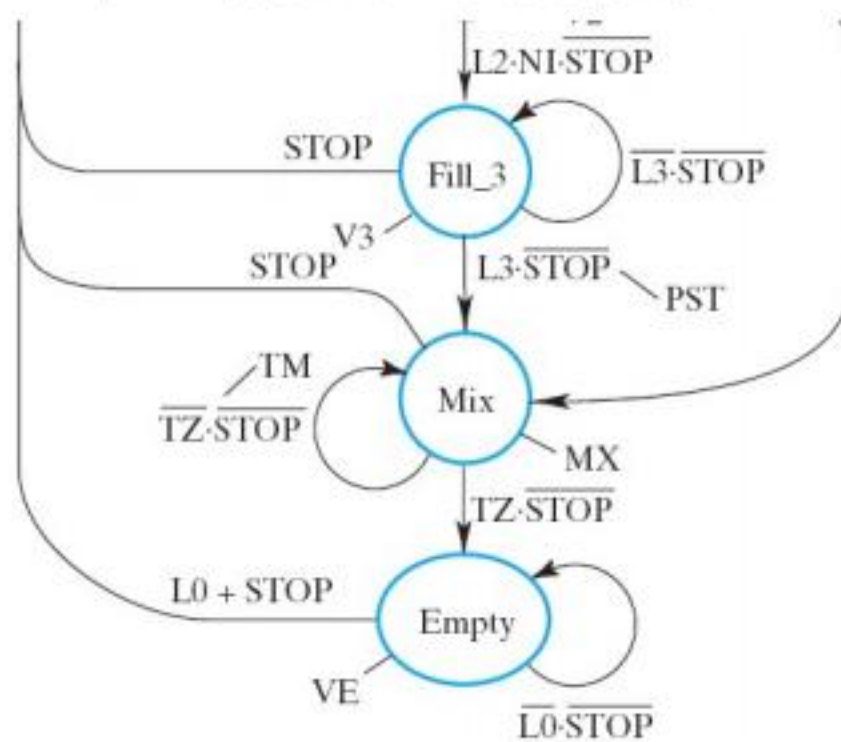
Default: $MX = 0$, $PST = 0$,
 $TM = 0$, $V1 = 0$, $V2 = 0$, $V3 = 0$,
 $VE = 0$



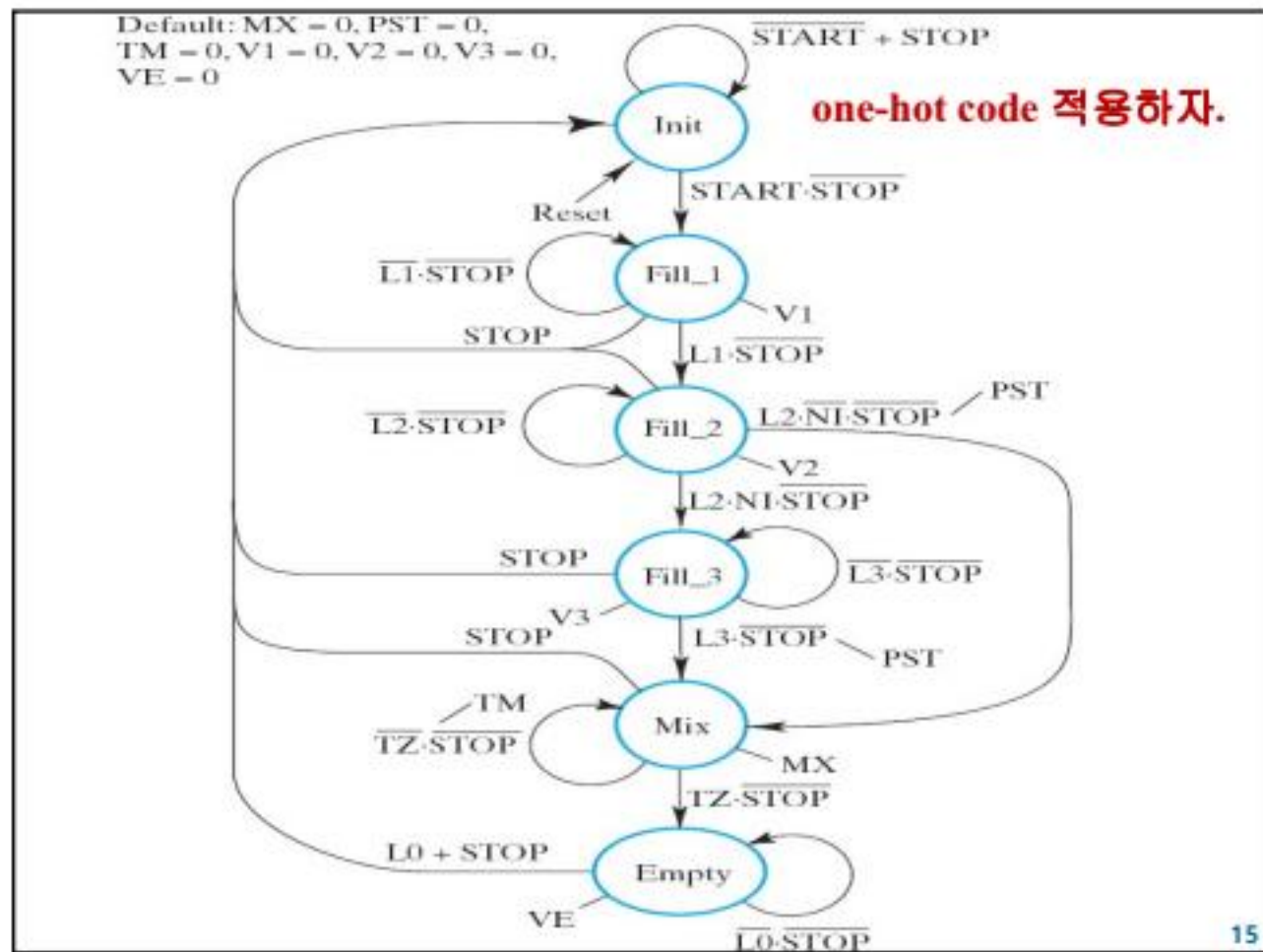
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State-Machine Diagram 응용 p.229

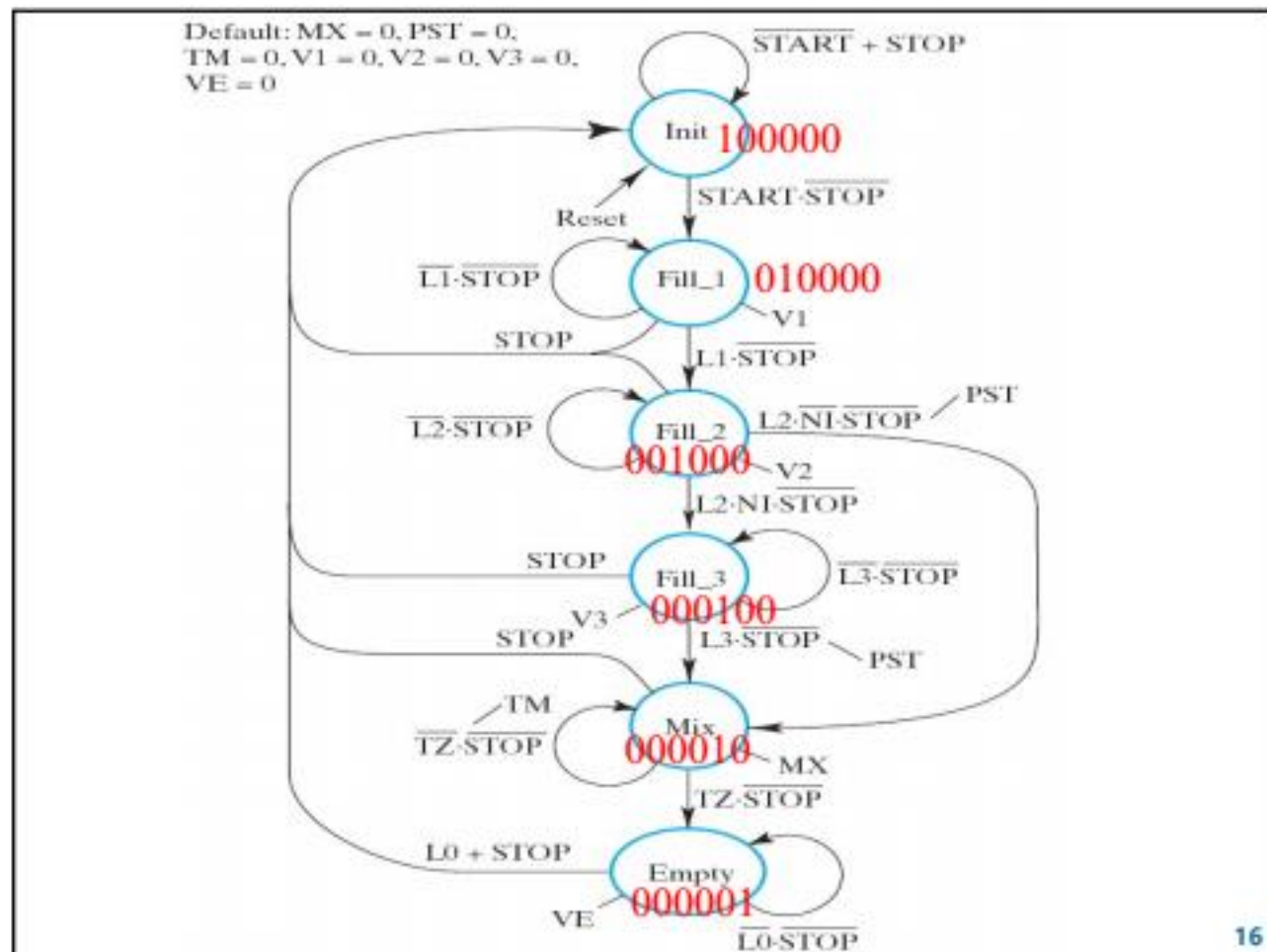
■ Batch 혼합 시스템 제어를 위한 상태기계설계



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State-Machine Diagram 응용" p.230

State	State Code	Transition Condition	Next State	State Code	Non-zero Outputs Including Mealy Outputs Using TCs*
Init	100000	$\overline{\text{START}} + \text{STOP}$	Init	100000	
		$\text{START} \cdot \overline{\text{STOP}}$	Fill_1	010000	
Fill_1	010000	$\overline{\text{STOP}}$	Init	100000	V1
		$\text{L1} \cdot \overline{\text{STOP}}$	Fill_1	010000	
		$\text{L1} \cdot \text{STOP}$	Fill_2	001000	
Fill_2	001000	$\overline{\text{STOP}}$	Init	100000	V2
		$\text{L2} \cdot \overline{\text{STOP}}$	Fill_2	001000	
		$\text{L2} \cdot \text{NI} \cdot \overline{\text{STOP}}$	Mix	000010	PST*
		$\text{L2} \cdot \text{NI} \cdot \text{STOP}$	Fill_3	000100	
Fill_3	000100	$\overline{\text{STOP}}$	Init	100000	V3
		$\text{L3} \cdot \overline{\text{STOP}}$	Fill_3	000100	
		$\text{L3} \cdot \text{STOP}$	Mix	000010	PST*

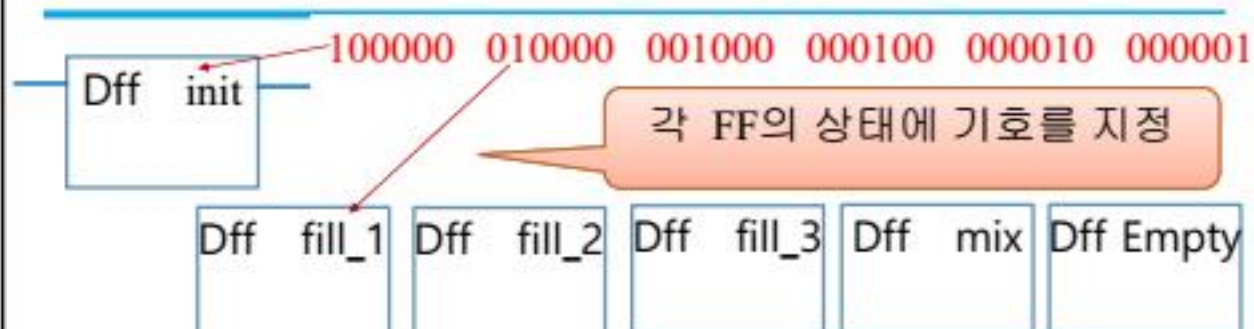
Moore output

OC / output

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State-Machine Diagram 응용" p.230

Mix	000010				MX
		$\overline{\text{STOP}}$	Init	100000	
		$\text{TZ} \cdot \overline{\text{STOP}}$	Mix	000010	TM*
		$\text{TZ} \cdot \text{STOP}$	Empty	000001	
Empty	000001	$\overline{\text{LO}} \cdot \overline{\text{STOP}}$	Empty	000001	VE
		$\text{LO} + \text{STOP}$	Init	100000	



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p.228 Batch 혼합 시스템을 위한 FF입력식

- 다음 상태가 Init이 되는 변이조건을 모두 연산한다.

$$\begin{aligned} \text{Init}(t+1) &= \text{Init} \cdot (\text{start}' + \text{stop}) + \text{fill1} \cdot \text{stop} + \text{fill2} \cdot \text{stop} + \text{fill3} \cdot \text{stop} \\ &\quad + \text{mix} \cdot \text{stop} + \text{empty} \cdot (\text{Lo} + \text{stop}) \\ &= \text{Init} \cdot \text{start}' + \text{Init} \cdot \text{stop} + \text{fill1} \cdot \text{stop} + \text{fill2} \cdot \text{stop} + \text{fill3} \cdot \text{stop} \\ &\quad + \text{mix} \cdot \text{stop} + \text{empty} \cdot \text{Lo} + \text{empty} \cdot \text{stop} \\ &= \text{Init} \cdot \text{start}' + \text{stop} + \text{empty} \cdot \text{Lo} \end{aligned}$$

상태를 **one-hot코드로 지정**했으므로

각 FF의 상태기호를 Init, fill1, fill2, fill3, mix, empty라 부를 수 있다.

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p.228 Batch 혼합 시스템을 위한 FF입력식'

- 다음 상태가 fill1, fill2, fill3이 되는 변이식

$$\begin{aligned} \text{fill1}(t+1) &= \text{init} \cdot \text{start} \cdot \text{stop}' + \text{fill1} \cdot \text{L1}' \cdot \text{stop}' \\ \text{fill2}(t+1) &= \text{fill1} \cdot \text{L1} \cdot \text{stop}' + \text{fill2} \cdot \text{L2}' \cdot \text{stop}' \\ \text{fill3}(t+1) &= \text{fill2} \cdot \text{L2} \cdot \text{NI} \cdot \text{stop}' + \text{fill3} \cdot \text{L3}' \cdot \text{stop}' \end{aligned}$$
- empty(t+1) 변이식...
- 출력 V1, V2, V3, Pst, Mix, Tm 출력식을 구한다.

p.229 에 출력식

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정리

- State-Machine Diagram 의 이해
- State-Machine Diagram의 제약조건1,2
- 설계에>
 - 동작 제어 시스템에서의 State-Machine Diagram
 - ➔ 상태표 ➔ 설계를 위한 FF입력식과 출력식

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