

EMFG

2002 8

EMFG

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.....
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The EMFG representation of a timer-relay

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Pukyong National University*

Abstract

EMFG(Extended Mark Flow Graph) constituted by box, transition and arc is a both-sides graph. It has the concurrent, asynchronous, distributed and parallel properties of Petri Net. Also it make easily the conception-design and dynamic analysis of system, therefore it can be used a powerful tool of modeling and designing of the control circuit about a dispersed control system and a factory automation.

However, it dose not concretely proposed the method of declaration about the timer in the existing EMFG, so it is difficult to express a sequence control and a relay circuit in the field of which using a timer. And it used the transition marked by double-bar as the method of a timer declaration. Therefore, the behavior of timer can be expressed more clearly and simplified. Also, as the transition marked by double-bar an be applied to a representation field of the general EMFG, it can be more simplified to realize the representation of EMFG.

1.

가 . 가

PLC(Programmable Logic Controller)

가

[1-2]. PLC

PLC

[3-5].

LD(Ladder

Diagram) PLC

PLC

가 ,

LD

PLC

EMFG(

; Extended Mark Flow Graph)

(PN: Petri-Net)[6- 14]

EMFG , , , 가

[15- 23].

EMFG

가 가 , EMFG

EMFG

EMFG

가

가

가

EMFG

2.

EMFG

EMFG

2.1 EMFG

, 가

가 [3- 14].

(MFG; Mark Flow Graph)

EMFG(

)가 [15,19- 20].

EMFG

가

EMFG

[3- 5,19- 20].

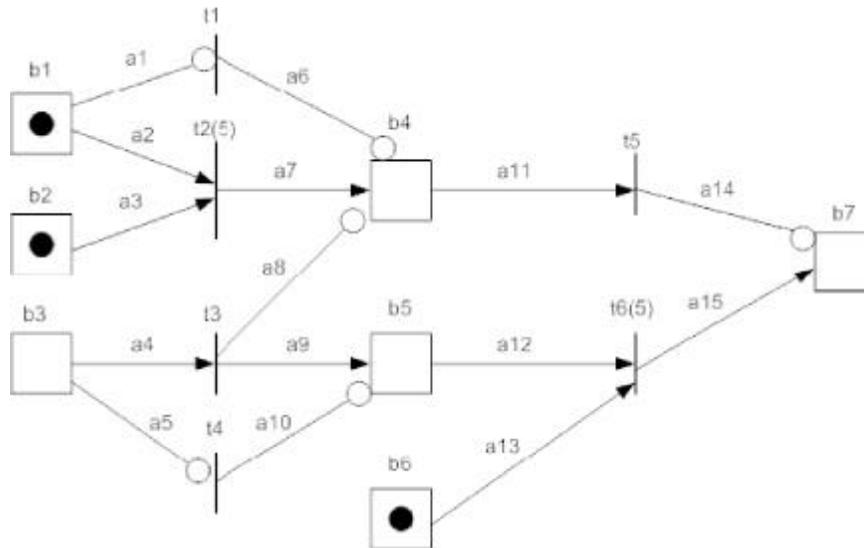
2.1.1 EMFG

EMFG

. EMFG G 1 [19- 20].

$G = \{ B, T, I, O, M \}$ [1]

(box) B, (transition) T,
 I, O
 M .
 (, ,) ,
 1 b1 b7 . b1,
 b2, b6 . 가
 , . b1, b2, b3, b6
 가 (source)
 .
 () 가 가
 () , 가 .
 가 (fire)
 .
 t1, t3, t4, t5
 bar() . t2(5), t5(5)
 bar t() .
 . 가 .
 , 1
 a2, a3, a4, a7, a9, a11, a12, a13, a15가 .
 1 a1, a5, a6, a8, a10, a14 . 1 a1, a5
 가
 , 1 a6,
 a8, a10, a14 가



1. EMFG

EMFG (safe)

0 1

I O

M

EMFG

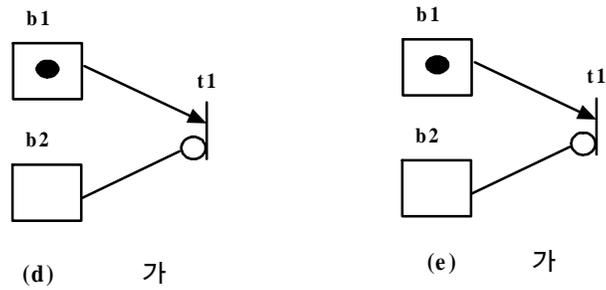
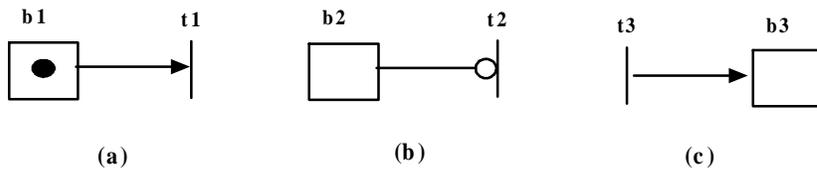
2.1.2

() 가 가
 ()

(1)

() 가
 가 .
 () 가 .

[19-20].



2.

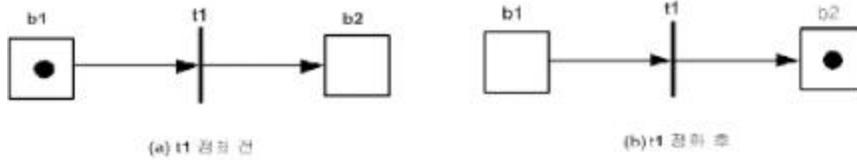
2 (a) 가
 , 2 (b)
 가 . 2 (c) t3

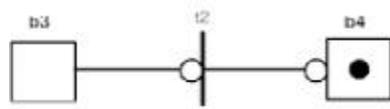
(source transition; 가)

2 (d) (e) ()
가

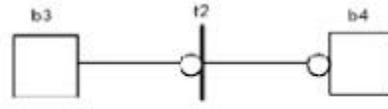
(2)

,
3(a)
3(b), 3(c)
2(d),
3(e),(f) / 가
/ / , 가 /
EMFG 3 (g), (h) (conflict box;
가) 가
[19-20].

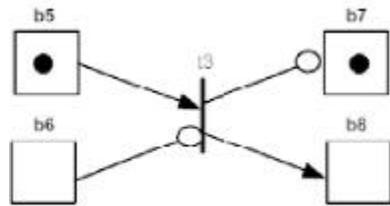




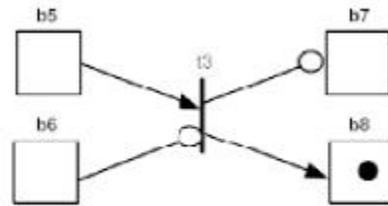
(c) t2 점화 전



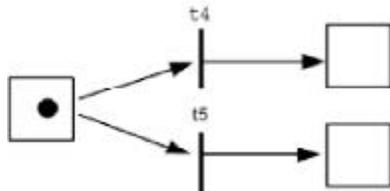
(d) t2 점화 전



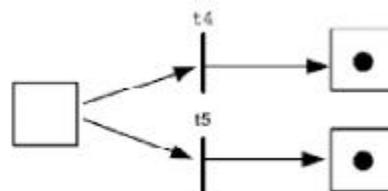
(e) t3 점화 전



(f) t3 점화 후



(g) t4, t5 점화 전



(h) t4, t5 점화 후

3.

(3)

가 . ,

가

[19-20].

4 (a)

t1

b1

가

4 (b)

가 .

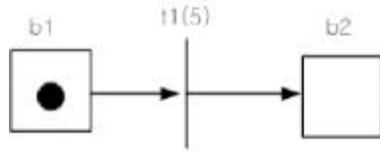
b1

가

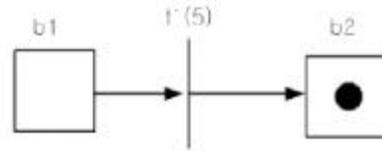
가

t1

b2 가



(a) 점화 전



(b) 점화 후

4.

2.1.3

EMFG

() (Self arc)

(Condition arc)

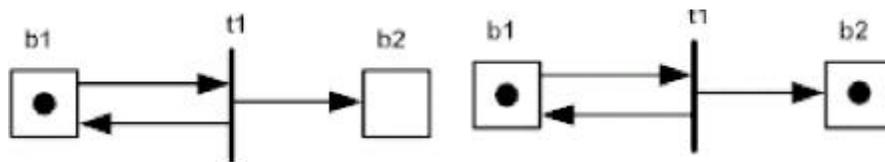
EMFG

[19-23].

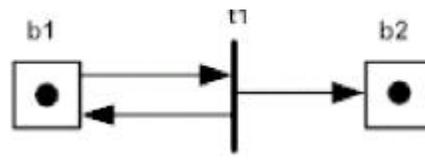
(1)

가

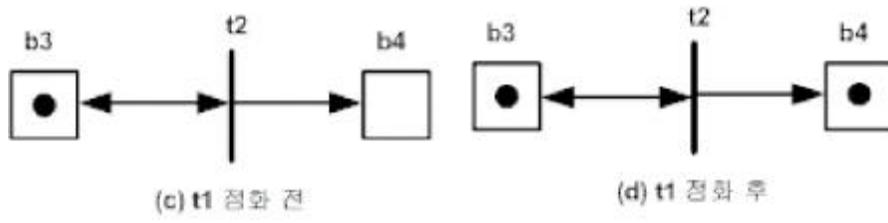
가



(a) t1 점화 전



(b) t1 점화 후



5.

5 (a) b1 ,
 b1 가 . . 가
 5 (c), (d) , 5 (a), (b)
 5 (c), (d) .

(2)

(Condition arc)

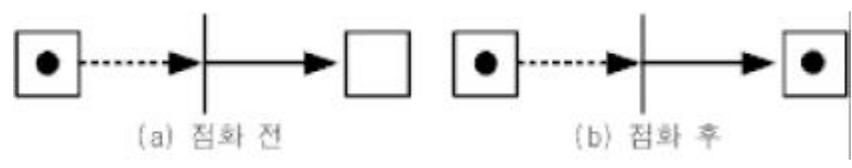
가

6 (a)

가

6 (a)

b1 가 t1 6 (b)
 b1 .

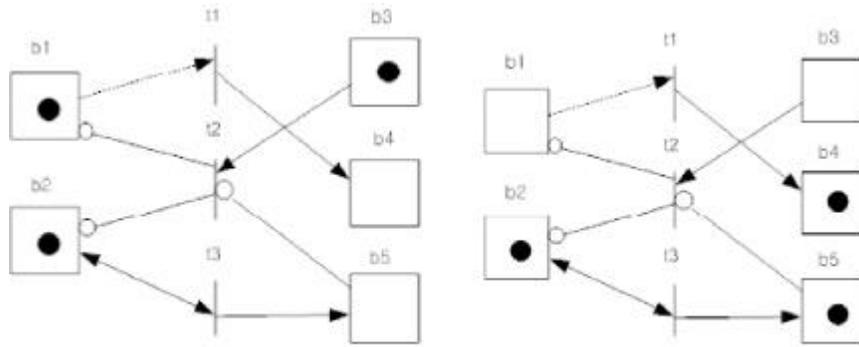


6.

가 ,

가

7 b1, b2, b3 가 t1, t2, t3
 , 가 7 b1
 , () 가 b2



(a) 트랜지션 점화전

(b) 트랜지션 점화후

7. () 가 EMFG

2.2.

2.2.1

가

(feedback control)

(sequential control)

[1-2].

()

가

2.2.2

가 . 가

가 [3-5].

[3-5].

[3-5].

()

[3-5].

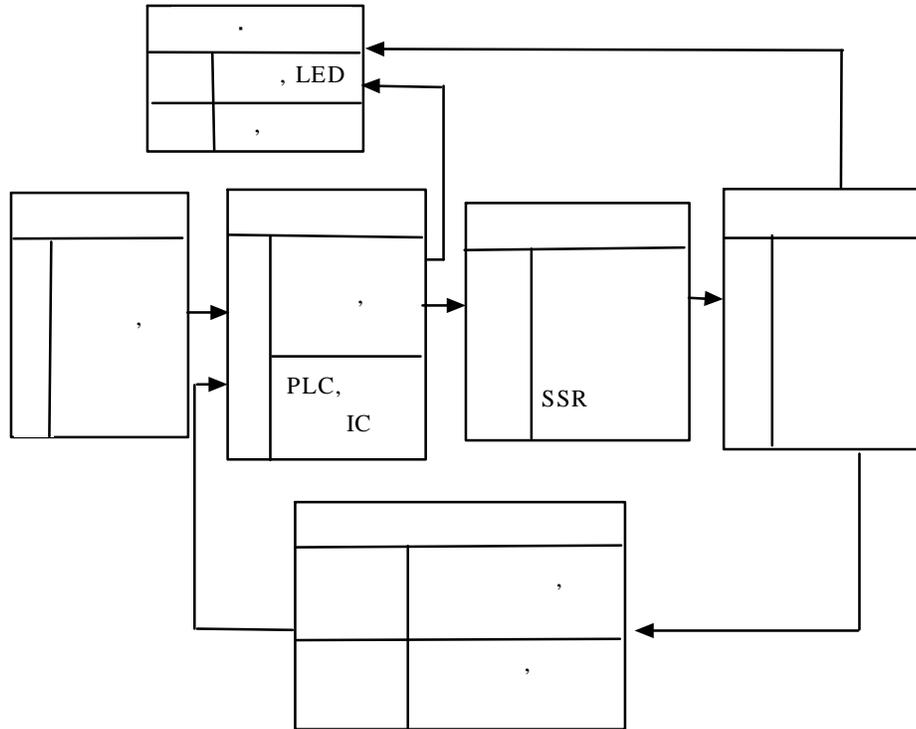
2.2.3

,
가 ,
· , 가 ·
· 1 0 , , ,
· , , ,
[1-5].

2.2.4

8
, , [2].
,
가

가 , 가
 가 .



8.

2.2.5

가 (ON),
 (OFF)

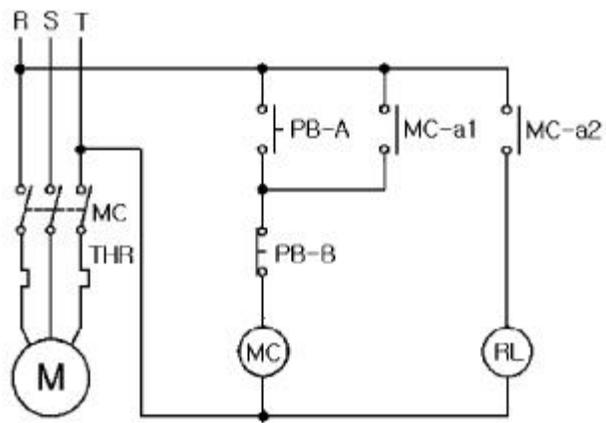
[1-2].

9

가 가 가

가

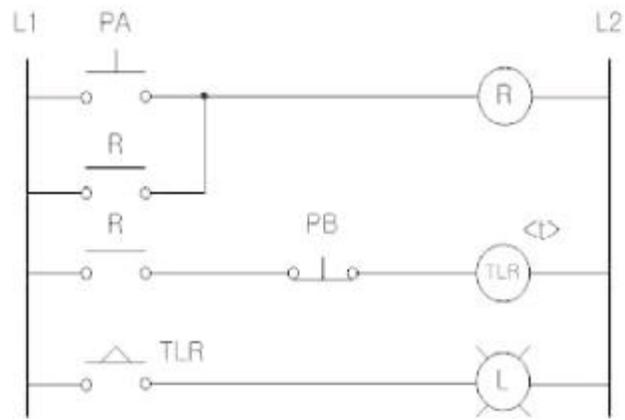
[1-2].



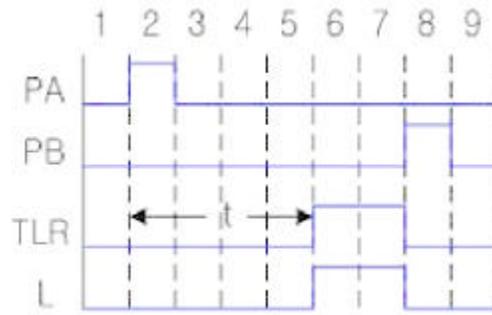
9.

2.3

가



(a)



(b)

10.

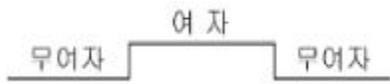
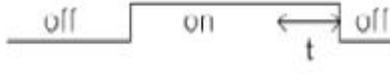
3.2.2

(-) 가 가
 , 가

[1-2].

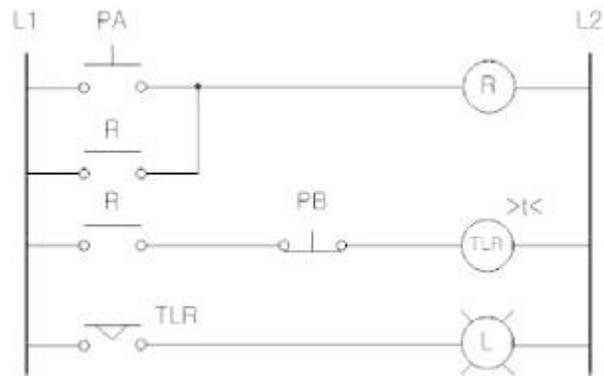
2

< 2 >

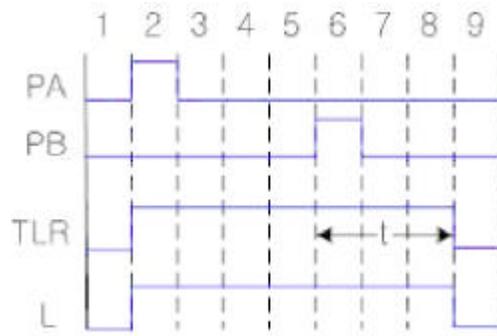
			
	a		
	b		

11

A 가 , B
 T가 , t
 TLR 가 .



(a)



(b)

11.

3. EMFG

EMFG ,
.

3.1 EMFG

EMFG .

3.1.1 EMFG

EMFG , 가

,
.
가

,

가

.

가 .

EMFG

10

EMFG

EMFG

1 : 10(a)

가

: PB, R, TLR

→ pb, r, tlr

PB

, R TLR

. TLR

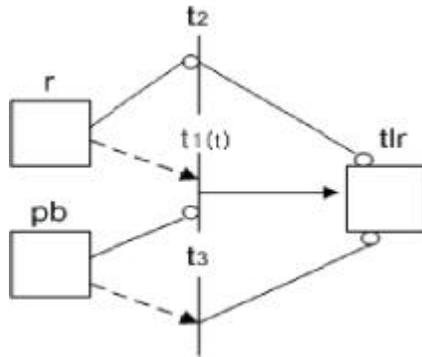
2 : 10(a)

TLRg = R · PB TLRd = R' , PB

3 : 2

EMFG

11



11.

EMFG

3.1.2

EMFG

EMFG

,

가

가

가

가

EMFG

11

EMFG

1 : 11(a)

가

: PB, R, TLR

→ pb, r, tlr

PB

, R TLR

. TLR

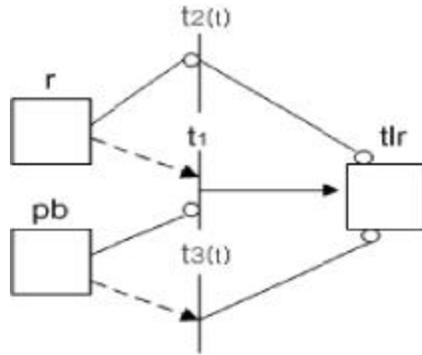
2 : 11(a)

TLRg = R · PB TLRd = R', PB

3 : 2

EMFG

13 .



13.

EMFG

3.2

가

EMFG

가

[22-23].

EMFG

가

가

가

EMFG가

(double-bar)

가

EMFG

3.2.1

EMFG

1) EMFG

tn가

bm

: tn

bm

bm

가

, '<' '>'

: tn

bm

bm

, tn bm

가

, '>'

'<'

1) Tg 가

t_{g t d}

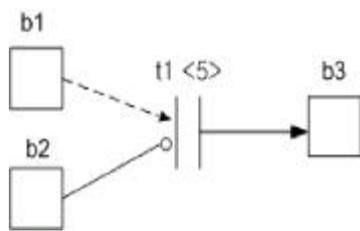
Td 가

t_{g d t}

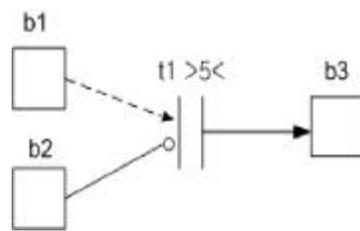
$t_{g \ t \ d}$ $t_{g \ t \ d}$ 가 T g
 $t_{g \ t \ d}$ AND-OR .

 $t_{g \ d \ t}$ $t_{g \ d \ t}$ 가 $t_{g \ t \ d}$
 AND-OR T d

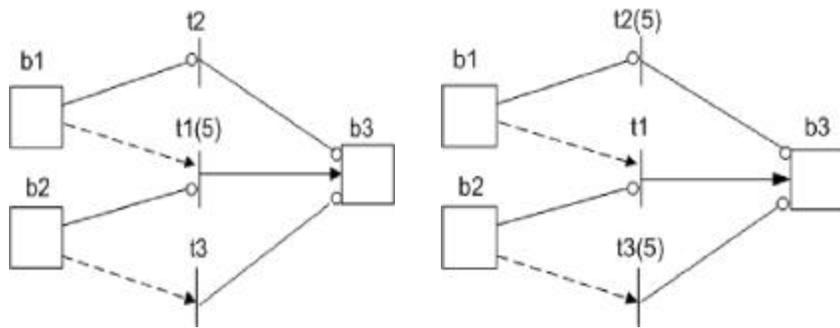
) 1 .
14 - -
1 15 ,



(a) -
14. -



(b) -
-



(a) 14(a)

(b) 14(b)

15. 14

EMFG

3.2.2

- , - ,

- -

EMFG

.

.

가

EMFG

.

2) EMFG

b_m b_n

t_n 가

,

-

-

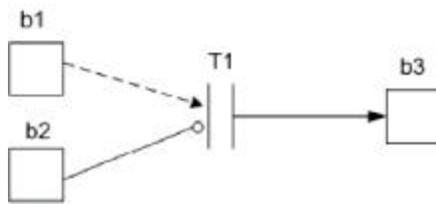
.

- : tn bm
 , bm
 , tn bm - ,
 가 , tn bm .

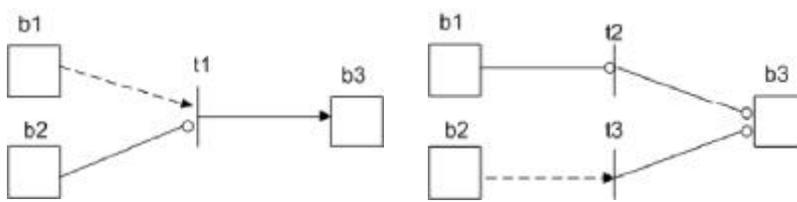
- : tn bm
 , bm
 , tn bm - ,
 가 , tn bm .

: tn bm
 , bn
 bm , bn
 , tn bm, bn , 가
 , tn bm , tn bn
 .

- 16 (a) b1=1, b2=0
 (b) b3
 , b1=0 b2=1 (c)
 b3 . 16
 (a) EMFG (d) EMFG가 .

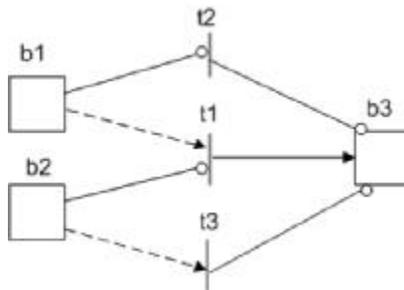


(a) -



(b)

(c)



(d)

16(a)

EMFG

16. -

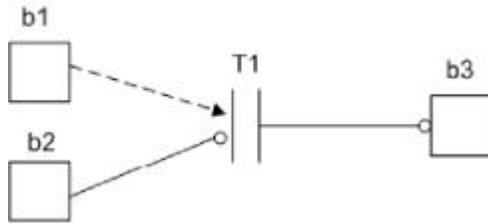
- 17 (a) $b_1=1, b_2=0$

(b) b_3

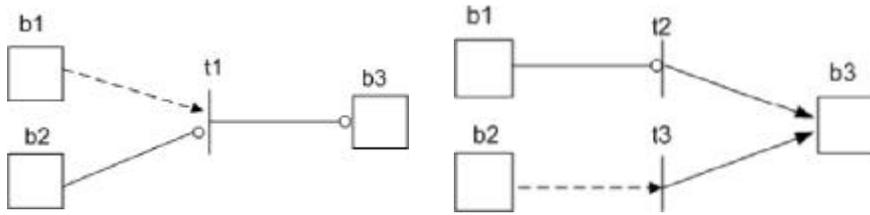
, $b_1=0$ $b_2=1$ (c)

b_3 17

(a) EMFG (d) EMFG가

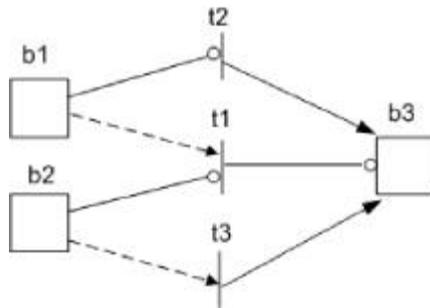


(a) -



(b)

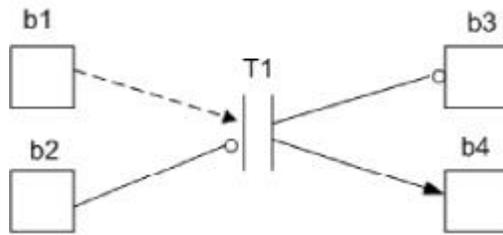
(c)



(d) 17(a) EMFG

17. -

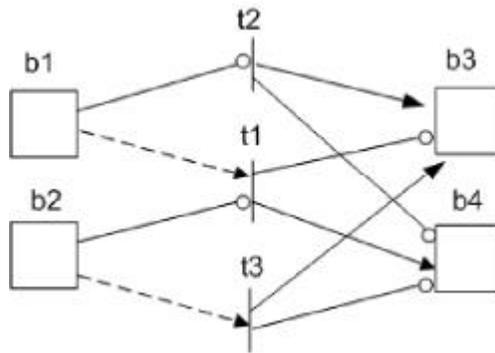
18 . b=1, b=0
 b3 , b4 . b1=0
 b2=1 b3 , b4



18.

EMFG

19 .



19.

18

EMFG

18

19 EMFG

EMFG

4.

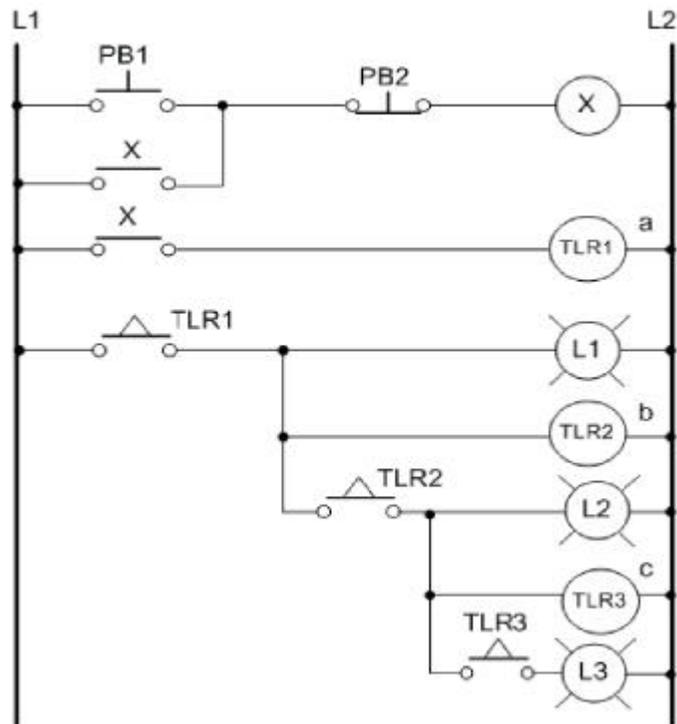
3

EMFG

4.1 가

18

(L1, L2, L3)



20. 가

: PB1, PB2, X, TLR1, TLR2, TLR3, L1, L2, L3

→ pb1, pb2, x, tlr1, tlr2, tlr3, l1, l2, l3

PB1

PB2

, X TLR1

. TLR1,

TLR2, TLR3

, L1, L2, L3

2 : 20

$X_g = PB1 * PB2'$

$X_d = PB2$

$TLR1_g = X$

$TLR1_d = X'$

$TLR2_g = TLR1$

$TLR2_d = TLR1'$

$TLR3_g = TLR2$

$TLR3_d = TLR2'$

$L1_g = TLR1$

$L1_d = TLR1'$

$L2_g = TLR2$

$L2_d = TLR2'$

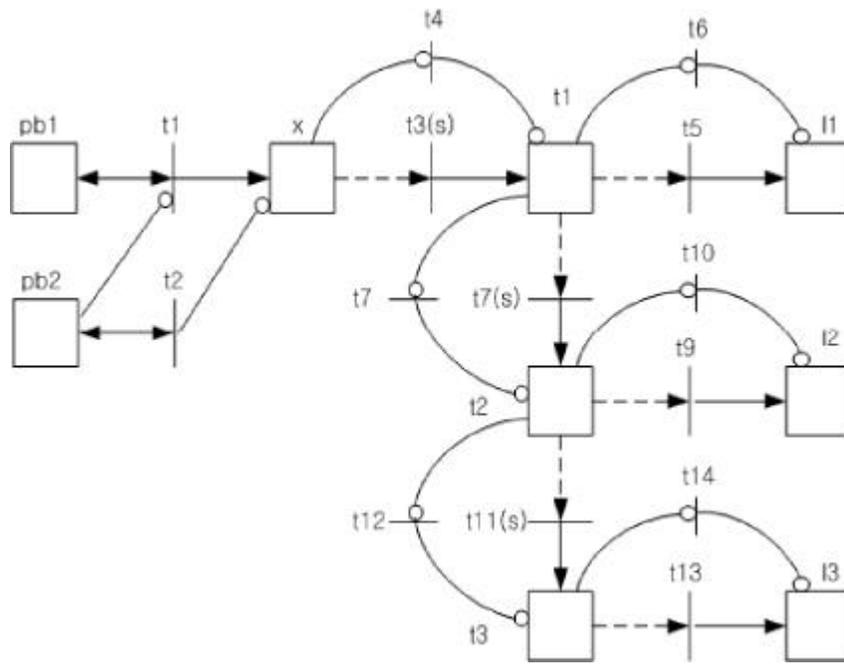
$L3_g = TLR3$

$L3_d = TLR3'$

3 : 2

EMFG

21

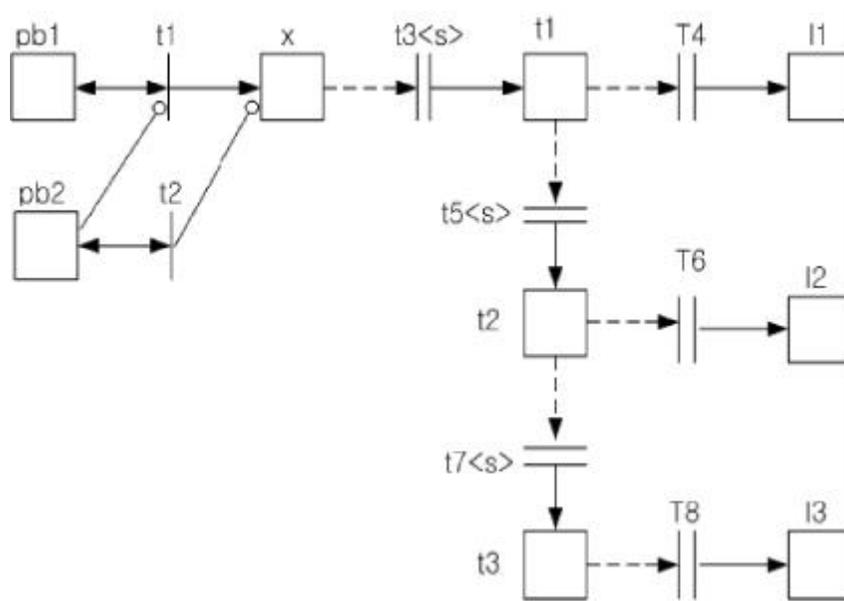


21. 20 EMFG

21 EMFG 14

29

22 EMFG가



22. 21 EMFG

22 EMFG 8 17

EMFG 6 12

EMFG가

6.

EMFG

EMFG

EMFG

- /

-

- / - /

EMFG

가

EMFG

,

EMFG

EMFG

EMFG

,

가

EMFG

- [1] , “ PLC ”, , 2001
- [2] , “PLC ”, , 2000
- [3] , , “ ”,
, 1998. 05, pp.252- 257
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Vol. 12. No 4, 1998. 8., p88-91
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[21] , , " "

”,
Vol. 5
No. 1, 2001. 5, p6921-695
[22] , , “ EMFG ”
[23] , , , “
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No. 2, 2001. 11, p821-826