目录

1 逻辑代数基础

1.7 将下列十进制数转换为十六进制和二进制。

100　127　255　16.5　50.375

$(100)_{10} = (64)_{16} = (1100100)_2$

$(127)_{10} = (7F)_{16} = (1111111)_2$

$(255)_{10} = (FF)_{16} = (11111111)_2$

$(16.5)_{10} = (10.8)_{16} = (10000.1)_2$

$(50.375)_{10} = (32.6)_{16} = (110010.011)_2$

1.8 将下列二进制数转换成十六进制数和十进制数。

$(1011)_2$　$(10000000)_2$　$(11001.011)_2$　$(1010.0101)_2$

$(1011)_2 = (B)_{16} = (11)_{10}$

$(10000000)_2 = (80)_{16} = (128)_{10}$

$(11001.011)_2 = (19.6)_{16} = (25.375)_{10}$

$(1010.0101)_2 = (A.5)_{16} = (10.3125)_{10}$

1.9 将下列十六进制数转换成二进制数和八进制数。

$(AF3C)_{16}$　$(0F)_{16}$　$(80)_{16}$　$(3BD.8)_{16}$

$(AF3C)_{16} = (1010\ 1111\ 0011\ 1100)_2 = (127474)_8$

$(0F)_{16} = (0000\ 1111)_2 = (017)_8$

$(80)_{16} = (1000\ 0000)_2 = (200)_8$

$(3BD.8)_{16} = (0011\ 1011\ 1101.1)_2 = (1675.4)_8$

1.10 写出下列二进制数的原码、反码和补码。

$(+1011)_2$　$(+00110)_2$　$(-1101)_2$　$(-00101)_2$

$(+1011)_2$, 原码 = 01011, 反码 = 01011, 补码 = 01011

$(+00110)_2$, 原码 = 000110, 反码 = 000110, 补码 = 000110

$(-1101)_2$, 原码 = 11101, 反码 = 10010, 补码 = 10011

$(-00101)_2$, 原码 = 100101, 反码 = 111010, 补码 = 111011

1.11 用真值表证明下面公式。

(1) $A \oplus 1 = \overline{A}$

(2) $A \oplus 0 = A$

(3) $A(B \oplus C) = AB \oplus AC$

(4) $A \oplus \overline{B} = \overline{A \oplus B}$

(5) $(A \oplus B) \oplus C = A \oplus (B \oplus C)$

(1) $\mathrm{A} \oplus 1 = \overline{\mathrm{A}}$

A	$\mathrm{A} \oplus 1$	$\overline{\mathrm{A}}$
0	1	1
1	0	0

(2) $\mathrm{A} \oplus 0 = \mathrm{A}$

A	$\mathrm{A} \oplus 0$	A
0	0	0
1	1	1

(3) $\mathrm{A}(\mathrm{B} \oplus \mathrm{C}) = \mathrm{AB} \oplus \mathrm{AC}$

A B C	AB	AC	$\mathrm{B} \oplus \mathrm{C}$	$\mathrm{A}(\mathrm{B} \oplus \mathrm{C})$	$\mathrm{AB} \oplus \mathrm{AC}$
0 0 0	0	0	0	0	0
0 0 1	0	0	1	0	0
0 1 0	0	0	1	0	0
0 1 1	0	0	0	0	0
1 0 0	0	0	0	0	0
1 0 1	0	1	1	1	1
1 1 0	1	0	1	1	1
1 1 1	1	1	0	0	0

(4) $\mathrm{A} \oplus \overline{\mathrm{B}} = \overline{\mathrm{A} \oplus \mathrm{B}}$

A B	$\overline{\mathrm{B}}$	$\mathrm{A} \oplus \mathrm{B}$	$\mathrm{A} \oplus \overline{\mathrm{B}}$	$\overline{\mathrm{A} \oplus \mathrm{B}}$
0 0	1	0	1	1
0 1	0	1	0	0
1 0	1	1	0	0
1 1	0	0	1	1

(5) $(\mathrm{A} \oplus \mathrm{B}) \oplus \mathrm{C} = \mathrm{A} \oplus (\mathrm{B} \oplus \mathrm{C})$

1.12 将下列函数化为最小项之和的形式

(1) $\mathrm{Y} = \overline{\mathrm{A}}\mathrm{BC} + \mathrm{AC} + \mathrm{B}\overline{\mathrm{C}}$

(2) $\mathrm{Y} = \mathrm{A}\overline{\mathrm{B}}\overline{\mathrm{C}}\mathrm{D} + \mathrm{BCD} + \mathrm{AC}$

(3) $\mathrm{Y} = AB + BC + ACD$

A B C	A ⊕ B	B ⊕ C	(A ⊕ B) ⊕ C	A ⊕ (B ⊕ C)
0 0 0	0	0	0	0
0 0 1	0	1	1	1
0 1 0	1	1	1	1
0 1 1	1	0	0	0
1 0 0	1	0	1	1
1 0 1	1	1	0	0
1 1 0	0	1	0	0
1 1 1	0	0	1	1

(4) $Y = AB + \overline{\overline{BC}(\overline{C} + \overline{D})}$

(1) $Y = \sum_m(2,3,5,6,7)$
(2) $Y = \sum_m(7,9,10,11,14,15)$
(3) $Y = \sum_m(6,7,11,12,13,14,15)$
(4) $Y = \sum_m(3,6,7,11,12,13,14,15)$

1.13 将下列函数化为最大项之积的形式

(1) $Y = (A+B)(\overline{A}+\overline{B}+\overline{C})$
(2) $Y = A\overline{B} + \overline{A}C$
(3) $Y = BC\overline{D} + \overline{A}D + C$
(4) $Y(A,B,C) = \sum(m_1, m_2, m_4, m_6, m_7)$

(1) $Y = (A+B+C)(A+B+\overline{C})(\overline{A}+\overline{B}+\overline{C}) = \prod M(0,1,7)$
(2) $Y = (A+B+C)(A+\overline{B}+C)(\overline{A}+\overline{B}+C)(\overline{A}+\overline{B}+\overline{C}) = \prod M(0,2,6,7)$
(3) $Y = (A+B+C+D)(\overline{A}+B+C+D)(A+\overline{B}+C+D)(\overline{A}+B+C+\overline{D})(\overline{A}+\overline{B}+C+D)(\overline{A}+\overline{B}+C+\overline{D}) = \prod M(0,4,8,9,12,13)$
(4) $Y = (\overline{A}+\overline{B}+\overline{C})(\overline{A}+B+C)(A+\overline{B}+C) = \prod M(0,3,5)$

1.14 写出图 P1.14 中各逻辑图的逻辑函数式，并化简成最简与-或式。

(a) $Y = \overline{\overline{(A\bar{B}C)} \cdot \overline{(B\bar{C})}} = A\bar{B}C + B\bar{C}$
(b) $Y = \overline{\overline{\bar{A}+C} + \overline{A+\bar{B}} + \overline{B+\bar{C}}} = (\bar{A}+C)(A+\bar{B})(B+\bar{C}) = ABC + \bar{A}\bar{B}\bar{C}$
(c) $Y = \overline{(A\oplus B)\oplus C} = \overline{(A\bar{B}+\bar{A}B)\oplus C} = (A\bar{B}+\bar{A}B)\bar{C} + \overline{(A\bar{B}+\bar{A}B)}C = \bar{A}BC + A\bar{B}C + ABC + \bar{A}\bar{B}\bar{C}$
(d) $Y_1 = \overline{\overline{AB + (A\oplus B)C}} = AB + (A\oplus B)C = AB + (A\bar{B}+\bar{A}B)C = AB + AC + BC$
$Y_2 = A\oplus B\oplus C = \bar{A}B\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}C + ABC$

1.15 已知逻辑函数的真值表如表 P1.15(a)、P1.15(b) 所示，写出对应的逻辑函数式。

(a) $Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$

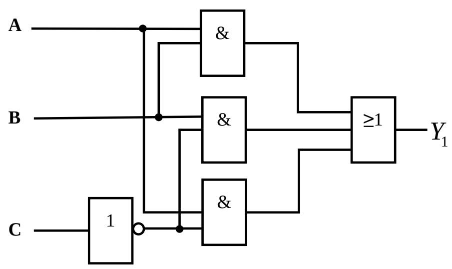
(b) $Z=\bar{M}\bar{N}PQ+\bar{M}NP\bar{Q}+\bar{M}NPQ+M\bar{N}PQ+MN\bar{P}\bar{Q}+MN\bar{P}Q+MNP\bar{Q}+MNPQ$

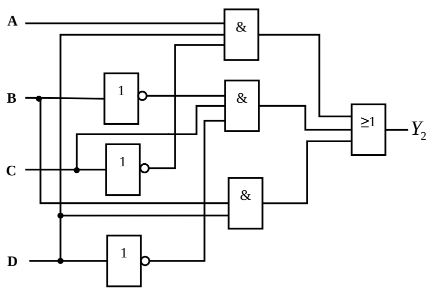
1.16 已知函数 $Y_1(A,B,C)=\bar{A}B\bar{C}+A\bar{B}\bar{C}+AB\bar{C}+ABC$, $Y_2(A,B,C,D)=A\bar{C}D+\bar{A}BD+BCD+\bar{B}C\bar{D}$

(1) 试用最少的与或非门画出 Y_1 和 Y_2 的逻辑电路图；

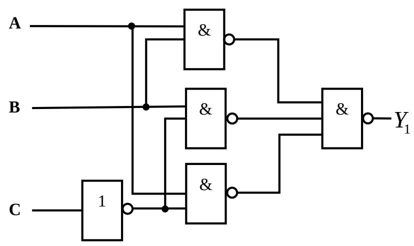
(2) 试用最少的与非门画出 Y_1 和 Y_2 的逻辑电路图。

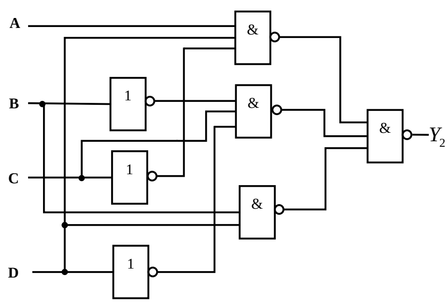
(1) $Y_1=AB+B\overline{C}+A\overline{C}$, $Y_2=A\overline{C}D+BD+\overline{B}C\overline{D}$





(2) $Y_1=\overline{\overline{AB}\cdot\overline{B\overline{C}}\cdot\overline{A\overline{C}}}$, $Y_2=\overline{\overline{A\overline{C}D}\cdot\overline{BD}\cdot\overline{\overline{B}C\overline{D}}}$





1.17 用反演定理，写出下列函数的反函数。

(1) $Y = (A+B)(\bar{A}+C)+BC$

$\bar{\mathrm{Y}} = \bar{\mathrm{A}}\bar{\mathrm{B}} + \mathrm{A}\bar{\mathrm{C}}$

(2) $Y = (\overline{A+C}+BD)(\overline{AD+\bar{B}C}+A\bar{B}D)$

$\bar{Y} = A+\bar{B}C+C\bar{D}$

(3) $Y = [\overline{(A+D)\overline{AC}}+\bar{A}B\bar{D}](\overline{A+C}+BD) = \overline{ACD}+ABCD$

$\bar{\mathrm{Y}} = \bar{\mathrm{A}}\mathrm{D}+\mathrm{A}\bar{\mathrm{C}}+\bar{\mathrm{B}}\mathrm{C}+\mathrm{C}\bar{\mathrm{D}} = A\overline{B}+A\overline{C}+\overline{A}D+C\overline{D}$

(4) $Y = \overline{(A\oplus C)(B+\bar{D})}(BD+AC) = AC+\overline{A}B\overline{C}D$

$\overline{\mathrm{Y}} = A\overline{C}+\overline{A}C+\overline{AB}+\overline{CD} = \overline{A}+B+\overline{C}+\overline{D}$

1.18 用对偶定理，写出下列函数的对偶式。

(1) $Y = A(B+C)+BC\overline{A\bar{B}}$

$Y' = (A+BC)\cdot(B+C+\overline{A+\bar{B}})$

(2) $Y = (A+C)(\bar{B}+\bar{D})+\overline{\bar{B}C+D}AD$

$\mathrm{Y}' = (\mathrm{AC}+\bar{\mathrm{B}}\bar{\mathrm{D}})[\overline{(\bar{\mathrm{B}}+\mathrm{C})\mathrm{D}}+\mathrm{A}+\mathrm{D}]$

(3) $Y = \overline{A\bar{B}+\bar{A}CD}+\overline{B+C}(A+\bar{B}+D)$

$Y' = [\overline{(A+\bar{B})(\bar{A}+C)+D}](\overline{BC}+A\bar{B}D)$

(4) $Y = \overline{(A+\bar{B})(\bar{C}+D)(A+B+\bar{C})}+(\bar{A}+\bar{B})C$

$Y' = \overline{A\bar{B}+\bar{C}D+ABC\bar{C}}(\bar{A}\bar{B}+C)$

1.19 用公式法将下列函数化简为最简与-或式。

(1) $\mathrm{Y} = \mathrm{A}+\mathrm{B}+\mathrm{C}$

(2) $\mathrm{Y} = 1$

(3) $\mathrm{Y} = \mathrm{AD}$

(4) $\mathrm{Y} = \mathrm{A}+\mathrm{CD}$

(5) $\mathrm{Y} = 0$

(6) $\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{B}}\bar{\mathrm{C}}\bar{\mathrm{D}}+\mathrm{ABCD}$

(7) $Y = ABCD\bar{E}$

(8) $\mathrm{Y} = \mathrm{A}+\mathrm{B}+\bar{\mathrm{C}}+\mathrm{D}$

1.20 用图形法化简下列函数为最简与-或式。

(1) $\mathrm{Y} = \mathrm{B}\bar{\mathrm{C}}+\mathrm{A}\bar{\mathrm{C}}$

(2) $\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{B}}+\mathrm{AC}$

(3) $Y = \bar{A}\bar{B}\bar{C}+A\bar{B}C+\bar{A}C\bar{D}+\bar{B}\bar{D}$ 函数不能再化简, 已为最简与或式。

(4) $\mathrm{Y} = \bar{\mathrm{A}}\mathrm{B}\bar{\mathrm{C}}+\mathrm{BCD}+\bar{\mathrm{A}}\mathrm{D}$

1.21 用图形法化简下列函数为最简与-或式。

(1) $\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{B}}+\mathrm{AC}+\mathrm{B}\bar{\mathrm{C}}$ 或者$\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{C}}+\mathrm{AB}+\bar{\mathrm{B}}\mathrm{C}$

(2) $\mathrm{Y} = \mathrm{C}$

(3) $\mathrm{Y} = \bar{\mathrm{B}}+\mathrm{C}\bar{\mathrm{D}}+\bar{\mathrm{A}}\bar{\mathrm{D}}$

(4) $\mathrm{Y} = \bar{\mathrm{B}}\bar{\mathrm{D}}+\mathrm{A}\bar{\mathrm{D}}+\bar{\mathrm{B}}\bar{\mathrm{C}}+\bar{\mathrm{A}}\bar{\mathrm{C}}D$

1.22 将下列函数化为最简与-或形式。

(4)

$$
\begin{aligned}
Y &= \overline{A\bar{B}\bar{C}D + A\bar{C}DE + \bar{B}D\bar{E} + A\bar{C}\bar{D}\bar{E}} \\
&= (\bar{A} + B + C + \bar{D})(\bar{A} + C + \bar{D} + \bar{E})(B + \bar{D} + E)(\bar{A} + C + D + E) \\
&= (\bar{A} + C + \bar{D} + B\bar{E})(\bar{A} + C + D + E)(B + \bar{D} + E) \\
&= (\bar{A} + C + (\bar{D} + B\bar{E})(D + E))(B + \bar{D} + E) \\
&= (\bar{A} + C + 0 + \bar{D}E + B\bar{E}D + 0)(B + \bar{D} + E) \\
&= (\bar{A} + C + \bar{D}E + BD\bar{E})(B + \bar{D} + E) \\
&= \bar{A}B + \bar{A}\bar{D} + \bar{A}E + BC + C\bar{D} + CE + B\bar{D}E + \bar{D}E + BD\bar{E} + 0 + 0 \\
&= \bar{A}B + \bar{A}\bar{D} + \bar{A}E + BC + C\bar{D} + CE + \bar{D}E + BD\bar{E} \\
&= \bar{A}\bar{D} + \bar{A}E + C\bar{D} + CE + \bar{D}E + BD\bar{E}
\end{aligned} \tag{1}
$$

(1) $\mathrm{Y} = \bar{\mathrm{A}} + \bar{\mathrm{B}} + \bar{\mathrm{C}} + \mathrm{D}$

(2) $Y = \mathrm{AB} + \bar{\mathrm{D}} + \bar{\mathrm{A}}\bar{\mathrm{C}}$

(3) $\mathrm{Y} = \mathrm{B}\bar{\mathrm{C}} + \bar{\mathrm{B}}\mathrm{D}$

(4) $\mathrm{Y} = \bar{A}\bar{D} + \bar{D}E + \bar{A}E + BD\bar{E} + CE + C\bar{D}$ 或 $\bar{A}E + CE + B\bar{E} + \bar{D}\bar{E}$

1.23 将下列函数化为最简与-或形式。

(1) $\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{C}}\bar{\mathrm{D}} + \bar{\mathrm{A}}\bar{\mathrm{B}}\bar{\mathrm{D}} + \mathrm{AD}$ 或 $\mathrm{Y} = \bar{\mathrm{A}}\bar{\mathrm{C}}\bar{\mathrm{D}} + \bar{\mathrm{B}}\mathrm{C}\bar{\mathrm{D}} + \mathrm{AD}$

(2) $\mathrm{Y} = \mathrm{B} + \bar{\mathrm{A}}\mathrm{D} + \mathrm{AC}$

(3) $\mathrm{Y} = \bar{\mathrm{A}} + \mathrm{B} + \mathrm{C}$

(4) $\mathrm{Y} = \bar{\mathrm{A}} + \bar{\mathrm{B}}\bar{\mathrm{D}}$

(5) $Y = 1.$

(6) $\mathrm{Y} = \mathrm{CD} + \mathrm{AC} + \bar{\mathrm{B}}\bar{\mathrm{D}}$

1.24 画出用最少数目的与非门和反相器实现下列函数的逻辑图。

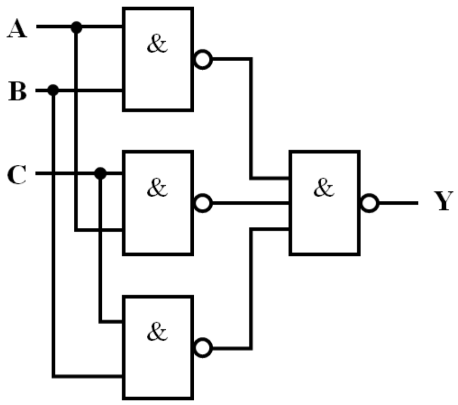
(1) $Y = AB + BC + AC$

(2) $Y(A,B,C,D) = \sum(m_0, m_1, m_3, m_5, m_8, m_{10}, m_{11}, m_{14})$

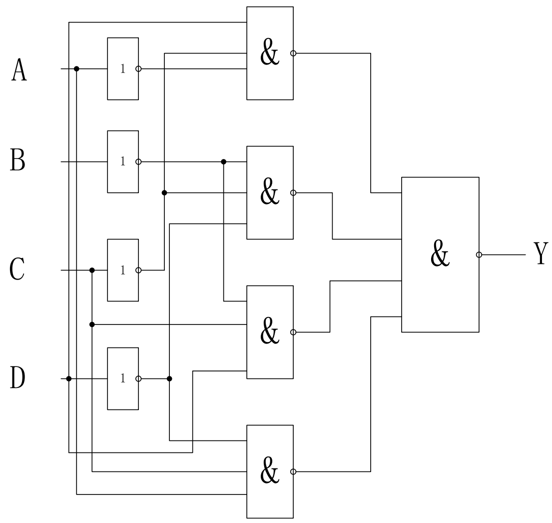
(3) $Y = A\overline{BC} + \overline{\overline{A\overline{B}} + \overline{AB} + BC}$

(4) $Y(A,B,C,D) = \sum(m_0, m_1, m_2, m_6, m_7, m_8, m_9, m_{10}, m_{14}, m_{15})$

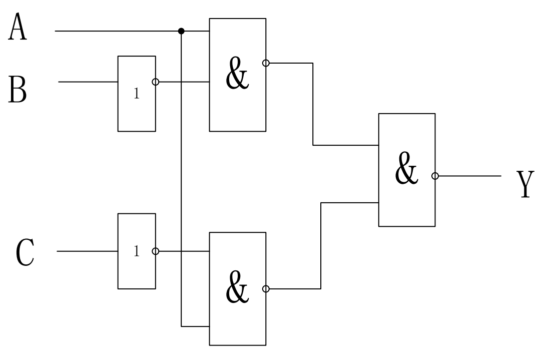
(1) $\mathrm{Y} = \overline{\overline{\mathrm{AB}} \cdot \overline{\mathrm{BC}} \cdot \overline{\mathrm{AC}}}$



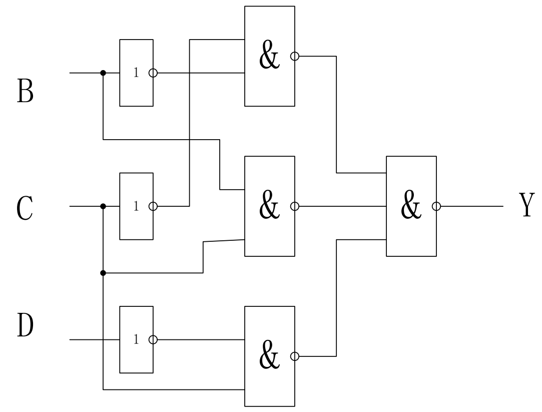
(2) $Y=\overline{\overline{\overline{B}\,\overline{C}\,\overline{D}}\cdot\overline{\overline{AC}D}\cdot\overline{\overline{B}CD}\cdot\overline{AC\overline{D}}}$

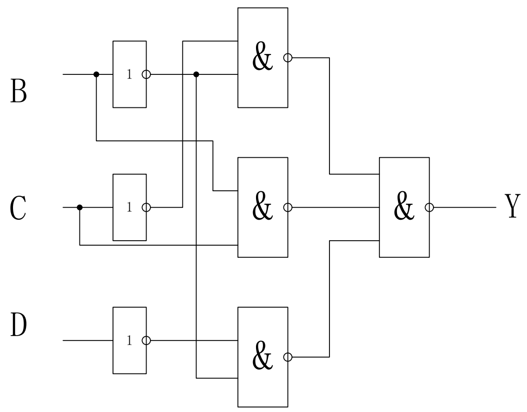


(3) $Y=\overline{\overline{A\overline{B}}\cdot\overline{A\overline{C}}}$



(4) $Y=\overline{\overline{\overline{B}\,\overline{C}}\cdot\overline{C\overline{D}}\cdot\overline{BC}}$ 或者 $Y=\overline{\overline{\overline{B}\,\overline{C}}\cdot\overline{\overline{B}\,\overline{D}}\cdot\overline{BC}}$


B
C
D
1
1
1
&
&
&
&
Y


B
C
D
1
1
1
&
&
&
&
Y

2 门电路

2.7 指出图 P2.7 中各门电路的输出是什么状态（高电平、低电平或高阻态）。已知这些电路是 74 系列 TTL 门电路。

(a) 低电平 (b) 高电平 (c) 高电平 (d) 低电平

(e) 高阻态 (f) 低电平 (g) 高电平 (h) 低电平

2.8 指出图 P2.8 中各门电路的输出状态。已知门电路是 CC4000 系列 CMOS 门电路。

(a) 高电平 (b) 低电平 (c) 低电平 (d) 低电平

2.10

$$\begin{aligned} G_{\mathrm{ML}} &= \frac{16\ \mathrm{mA}}{1.6\ \mathrm{mA}} = 10 \\ G_{\mathrm{MH}} &= \frac{4\ \mathrm{mA}}{40\ \mu\mathrm{A}} = 100 \end{aligned} \tag{2}$$

由于与非门 V_{IL} 输入时一门一路，所以 $G_M = 10$

2.11

$$\begin{aligned} I_{\mathrm{L\ max}}\ &\geqslant N_L \times 2I_{IS} \\ 16\ \mathrm{mA} &\geqslant NL \times 3.2\ \mathrm{mA} \\ NL &\leqslant 5 \end{aligned} \tag{3}$$

$$\begin{aligned} \mathrm{IoH\ max}\ &\geqslant N_H \times 2I_{\mathrm{IH\ max}} \\ 4mA &\geqslant N_H \times 2 \times 40\mu\mathrm{A} \\ N_H &\leqslant 50 \end{aligned} \tag{4}$$

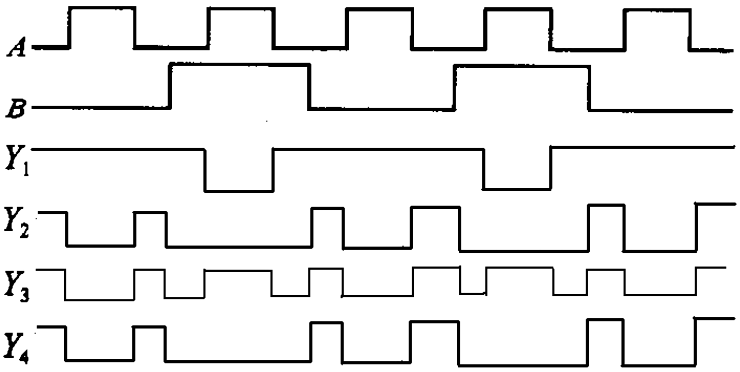
$$\therefore N = \min\{NL, NH\} = 5 \tag{5}$$

输入端改为 4 时. $\mathrm{f}: N_L \leqslant 2.5, N_H \leqslant 25, N = \min\{N_L, N_H\} = 2$

2.12

$$\begin{aligned} &R_L \times (8 - 3 \times 0.4) \geq 5 - 0.4 \\ &\therefore R_L \geq \frac{4.6}{6.8} \approx 0.7K\Omega = 700\Omega \\ &R_L(3 \times 100 + 3 \times 20) \leq 5 - 3.2 \\ &\therefore R_L \leq \frac{1.8}{360} = 0.005M\Omega = 5K\Omega \end{aligned} \tag{6}$$

2.13



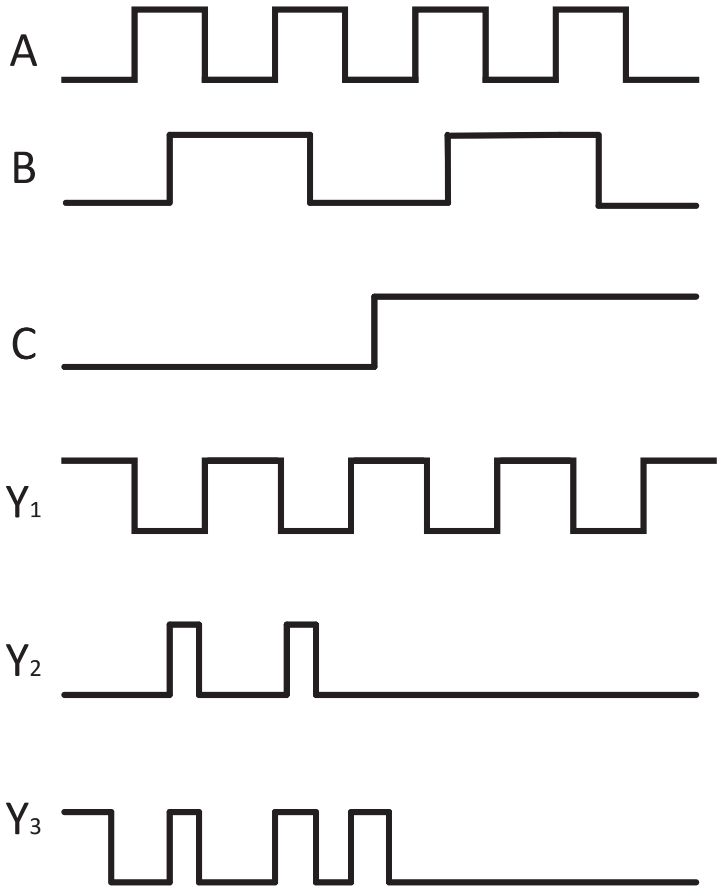
2.14 (1)

$Y_1 = \overline{A}(C=0)$ or 高阻 $(C=1)$;

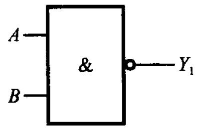
$Y_2 = AB\overline{C}$;

$Y_3 = \overline{(A \oplus B) + C}$;

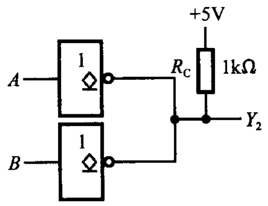
(2)



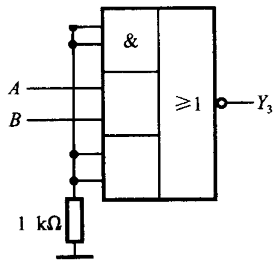
2.17 (1)



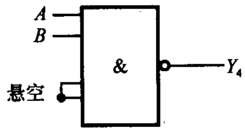
(a) $Y_1=\overline{A\cdot B}$



(b) $Y_2=\overline{A+B}$

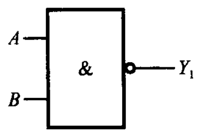


(c) $Y_3=\overline{A\cdot B}$

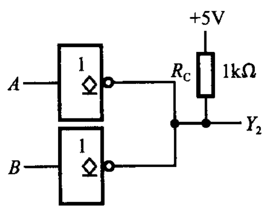


(d) $Y_4=\overline{A\cdot B}$

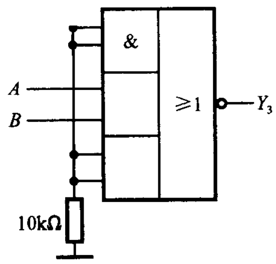
(2)



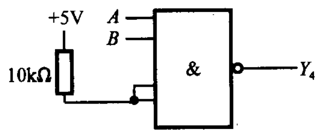
(a) $Y_1=\overline{A\cdot B}$



(b) $Y_2=\overline{A+B}$



(c) $Y_3=\overline{A\cdot B}$



(d) $Y_4=\overline{A\cdot B}$

2.19 (a) $Y=\overline{\overline{\overline{A}\times\overline{B}\times\overline{A}}}=\overline{A+B+C}$

(b) $Y=\overline{C}\times\overline{AB}$

3 组合逻辑电路

3.1 分析图 P3.1 电路的逻辑功能, 写出输出的逻辑函数式, 列出真值表, 说明电路逻辑功能的特点.
可有多种表示方式:
$Y = \overline{A \oplus B \oplus C}$
$Y = AB\overline{C} + A\overline{B}C + \overline{A}BC + \overline{A}\,\overline{B}\,\overline{C}$
$Y = A(B \oplus C)$
$Y = (A \oplus B)C$

A	B	c	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

由真值表可以看出, 此电路为检测 ABC 三变量中是否有奇数个零.

3.2 图 P3.2 是一个多功能函数发生器电路. 试写出当 $S_0S_1S_2S_3$ 为 0000 1111 16 种不同状态时输出 Y 的逻辑函数式.
$Y_1 = A \oplus B \oplus C$
$Y_2 = AB + (A \oplus B)C = AC + BC + AB$

S_0	S_1	S_2	S_3	Y
0	0	0	0	1
0	0	0	1	$A+B$
0	0	1	0	$\overline{A}+B$
0	0	1	1	B
0	1	0	0	$A+\overline{B}$
0	1	0	1	A
0	1	1	0	$\overline{A \oplus B}$
0	1	1	1	AB
1	0	0	0	$\overline{A}+\overline{B}$
1	0	0	1	$A \oplus B$
1	0	1	0	$\overline{A}$
1	0	1	1	$\overline{A}B$
1	1	0	0	$\overline{B}$
1	1	0	1	$A\overline{B}$
1	1	1	0	$\overline{AB}$
1	1	1	1	0

3.3 由半加器和或门组成的电路如图 P3.3 所示. 写出输出信号的逻辑表达式, 并说明其功能.

$Y_1 = A \oplus B \oplus C$

$Y_2 = AB + (A \oplus B)C = AC + BC + AB$

真值表如下: 由真值表可以看出, 电路为一个全加器. Y_1 为 A, B, C, 三变量之和, Y_2 为进位标志.

A	B	c	Y_2	Y_1
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

3.5 由 3 线-8 线译码器 74LS138 构成的电路如图 P3.5 所示. 写出输出函数的最简与-或式.

$Y_1 = \overline{AC} + A\overline{B}C + \overline{A}B = A$

$Y_2 = \overline{AB}C + A\overline{C} + AB = \overline{A}$

3.6

(1)

$$
\begin{aligned}
Y_1 &= A\bar{B} + A\bar{C}D + A\bar{C} \\
&= A\bar{B} + A\bar{C} \\
&= \overline{\overline{A\bar{B}} \cdot \overline{A\bar{C}}} \\
\text{或} Y_1 &= A\overline{BC} = \overline{\overline{A\overline{BC}}}
\end{aligned} \tag{7}
$$

(2)

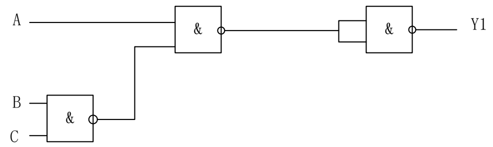
$$
\begin{aligned}
Y_2 &= A\bar{B} + \bar{A}C + B\bar{C} + ABD \\
&= A\bar{B} + \bar{A}C + B\bar{C}\bar{D} + AD \\
&= \overline{\overline{A\bar{B}} \cdot \overline{\bar{A}C} \cdot \overline{B\bar{C}\bar{D}} \cdot \overline{AD}}
\end{aligned} \tag{8}
$$

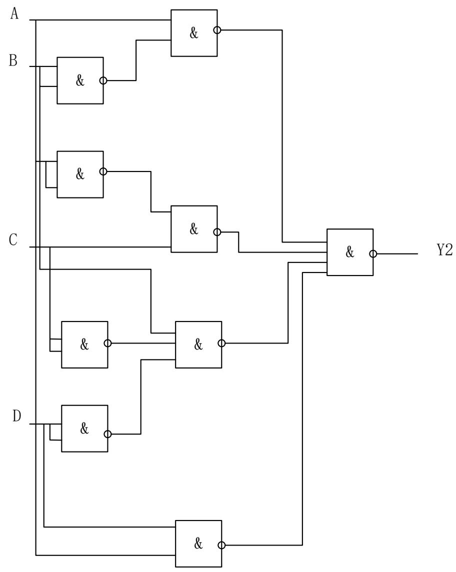
(3)

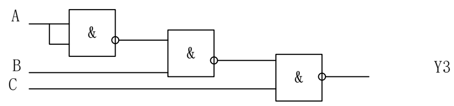
$$
\begin{aligned}
Y_3 &= \bar{C} + \bar{A}B \\
&= \overline{\overline{\bar{A}B} \cdot C}
\end{aligned} \tag{9}
$$

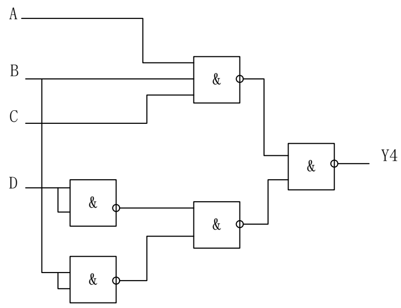
(4)

$$
\begin{aligned}
Y_4 &= \bar{B}\bar{D} + ABC \\
&= \overline{\overline{\bar{B}\bar{D}} \cdot \overline{ABC}}
\end{aligned} \tag{10}
$$


A
B
C
&
&
&
Y1


A
B
C
D
&
Y2


A
B
C
&
Y3

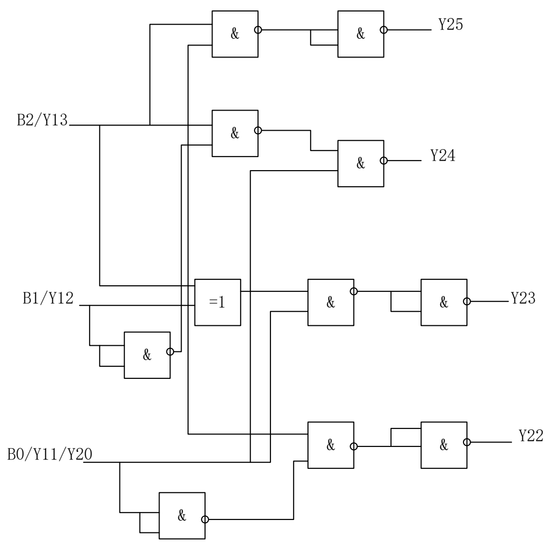

A
B
C
D
&
Y4

3.7

$$
\begin{aligned}
Y_{10} &= 0 \\
Y_{11} &= B_0 \\
Y_{12} &= B_1 \\
Y_{13} &= B_2 \\
Y_{20} &= B_0 \\
Y_{21} &= 0 \\
Y_{22} &= B_1\overline{B_0} \\
Y_{23} &= \overline{B_2}B_1B_0 + B_2\overline{B_1}B_0 \\
Y_{24} &= B_2\overline{B_1} + B_2B_0 \\
Y_{25} &= B_2B_1
\end{aligned} \tag{11}
$$

B_2	B_1	B_0	Y13	Y12	Y11	Y10	Y25	Y24	Y23	Y22	Y21	Y20
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	0	0	0	0	0	1
0	1	0	0	1	0	0	0	0	0	1	0	0
0	1	1	0	1	1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0	1	0	0	0	0
1	0	1	1	0	1	0	0	1	1	0	0	1
1	1	0	1	1	0	0	1	0	0	1	0	0
1	1	1	1	1	1	0	1	1	0	0	0	1

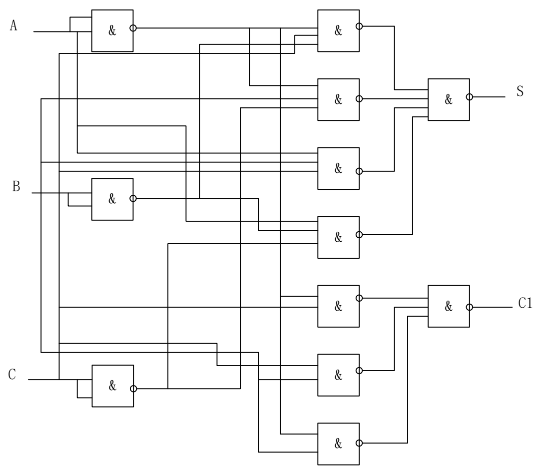
(12)



3.8

A	B	CI	S	C
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

(13)



3.9 解：以 ABCD 表示四个双位开关，并用 0、1 分别表示开关的两个状态，以 Y 表示灯的状态，1 表示亮，0 表示灭。并设 ABCD=0000 时 Y=0，从这个状态开始，单独改变任何一个开关的状态，Y 的状态都会改变。则真值表为：

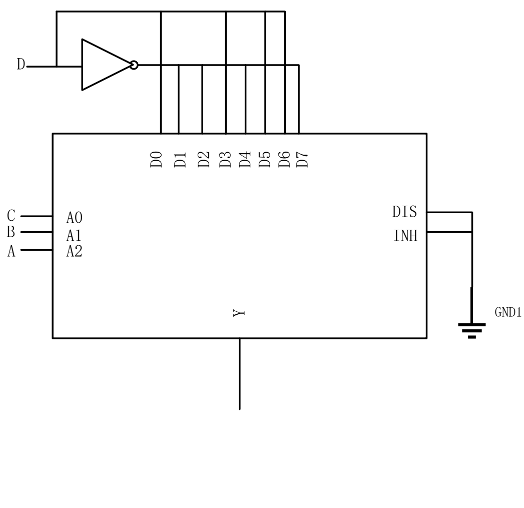
A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

(14)

则由真值表可得 Y 的表达式为:

$$\begin{aligned} Y &= \sum(m1, m2, m4, m7, m8, m11, m13, m14) \\ &= \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD \\ &+ A\bar{B}\bar{C}\bar{D} + A\bar{B}CD + AB\bar{C}D + ABC\bar{D} \end{aligned}$$

由 Y 的表达式可以看出, 出现了 ABC 三变量的所有最小项, 所以可以用 8 选 1 数据选择器 CC4512 完成, 将 ABC 作为地址输入, D 及其反变量接到数据输入端。电路图如下:



3.10

将 8421BCD 码分别转换为雷格码（循环码)、余 3 码、2421 码的真值表为:

(1) 根据上述真值表可得循环码与 8421BCD 码之间的转换关系为:

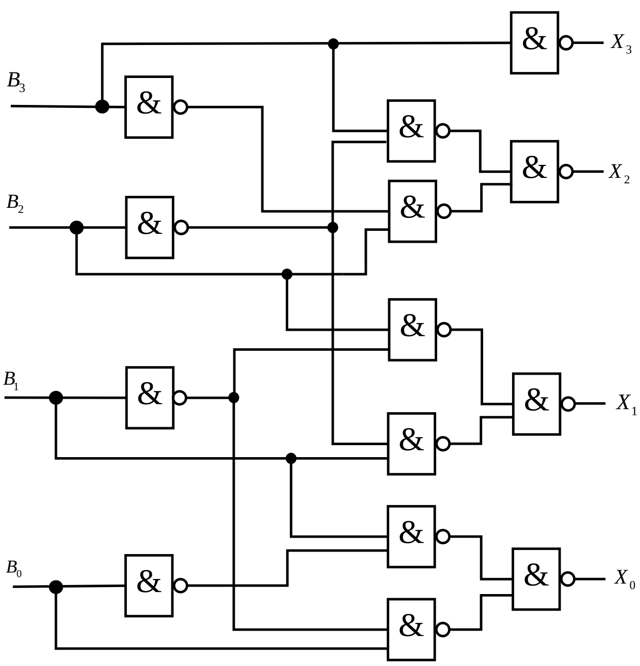
8421BCD 码				循环码				余 3 码				2421 码			
B3	B2	B1	B0	X3	X2	X1	X1	Y3	Y2	Y1	Y0	E3	E2	E1	E0
0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1
0	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0
0	0	1	1	0	0	1	0	0	1	1	0	0	0	1	1
0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0
0	1	0	1	0	1	1	1	1	0	0	0	1	0	1	1
0	1	1	0	0	1	0	1	1	0	0	1	1	1	0	0
0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	1
1	0	0	0	1	1	0	0	1	0	1	1	1	1	1	0
1	0	0	1	1	1	0	1	1	1	0	0	1	1	1	1
1	0	1	0	x	x	x	x	x	x	x	x	x	x	x	x
1	0	1	1	x	x	x	x	x	x	x	x	x	x	x	x
1	1	0	0	x	x	x	x	x	x	x	x	x	x	x	x
1	1	0	1	x	x	x	x	x	x	x	x	x	x	x	x
1	1	1	0	x	x	x	x	x	x	x	x	x	x	x	x
1	1	1	1	x	x	x	x	x	x	x	x	x	x	x	x

$X_3 = B_3$

$X_2 = \overline{B_3}B_2 + B_3\overline{B_2} = \overline{\overline{\overline{B_3}B_2} \cdot \overline{B_3\overline{B_2}}}$

$X_1 = \overline{B_2}B_1 + B_2\overline{B_1} = \overline{\overline{\overline{B_2}B_1} \cdot \overline{B_2\overline{B_1}}}$

$X_0 = \overline{B_1}B_0 + B_1\overline{B_0} = \overline{\overline{\overline{B_1}B_0} \cdot \overline{B_1\overline{B_0}}}$



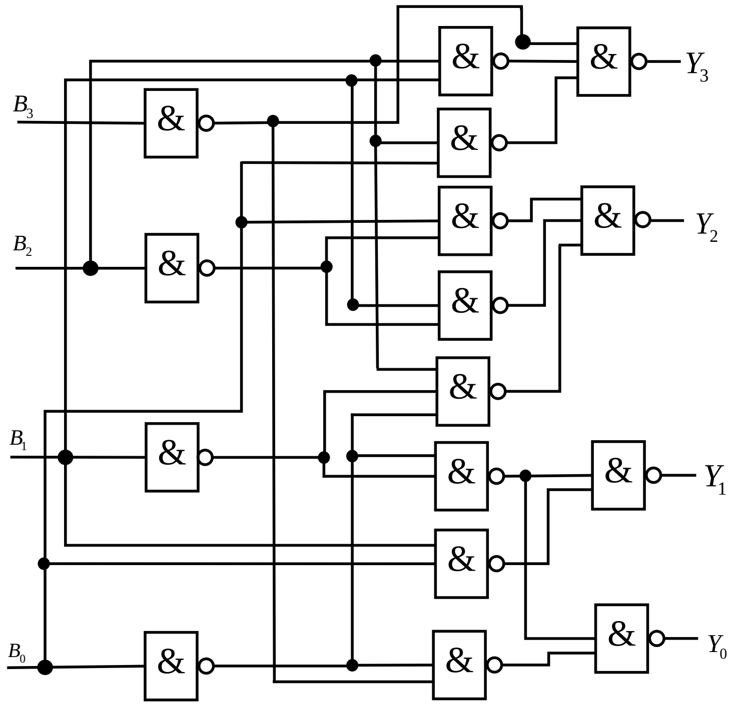
(2) 根据上述真值表可得余 3 码与 8421BCD 码之间的转换关系为:

$$Y_3 = B_3 + B_2B_0 + B_2B_1 = \overline{\overline{B_3} \cdot \overline{B_2B_0} \cdot \overline{B_2B_1}}$$

$$Y_2 = \overline{B_2}B_0 + \overline{B_2}B_1 + B_2\bar{B}_1\bar{B}_0 = \overline{\overline{\overline{B_2}B_0} \cdot \overline{\overline{B_2}B_1} \cdot \overline{B_2B_1\bar{B}_0}}$$

$$Y_1 = \bar{B}_1\bar{B}_0 + B_1B_0 = \overline{\overline{\bar{B}_1\bar{B}_0} \cdot \overline{B_1B_0}}$$

$$Y_0 = \bar{B}_1\bar{B}_0 + \bar{B}_3\bar{B}_0 = \overline{\overline{\bar{B}_1\bar{B}_0} \cdot \overline{\bar{B}_3\bar{B}_0}}$$



(3) 根据上述真值表可得 2421 码码与 8421BCD 码之间的转换关系为:

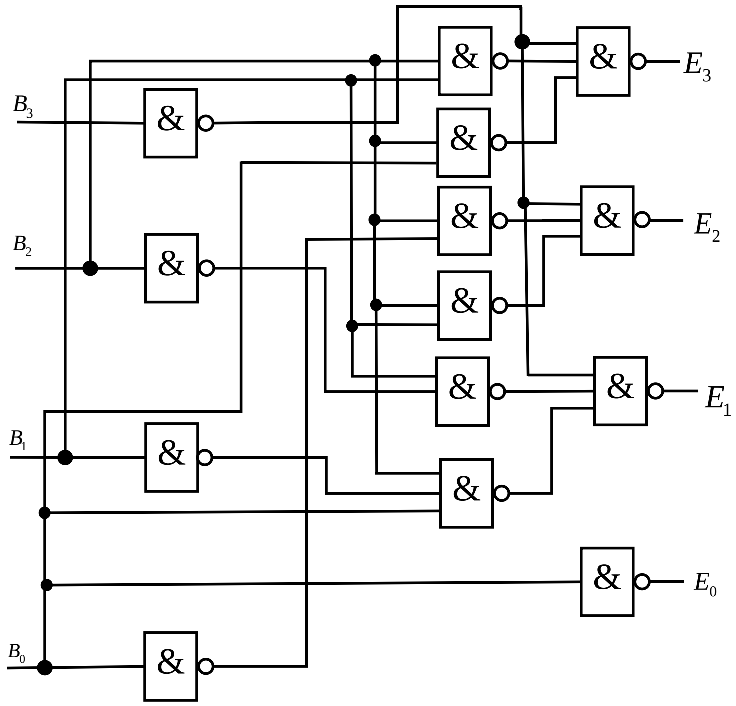
$$E_3 = B_3 + B_2B_0 + B_2B_1 = \overline{\overline{B_3} \cdot \overline{B_2B_0} \cdot \overline{B_2B_1}}$$

$$E_2 = B_3 + B_2\overline{B_0} + B_2B_1 = \overline{\overline{B_3} \cdot \overline{B_2\overline{B_0}} \cdot \overline{B_2B_1}}$$

$$E_1 = B_3 + \overline{B_2}B_1 + B_2\overline{B_1}B_0 = \overline{\overline{B_3} \cdot \overline{\overline{B_2}B_1} \cdot \overline{B_2\overline{B_1}B_0}}$$

$$E_0 = B_0$$

化简得逻辑函数表达式为：$Y = \overline{\overline{BCD} \cdot \overline{ACD} \cdot \overline{ABD} \cdot \overline{ABC}}$

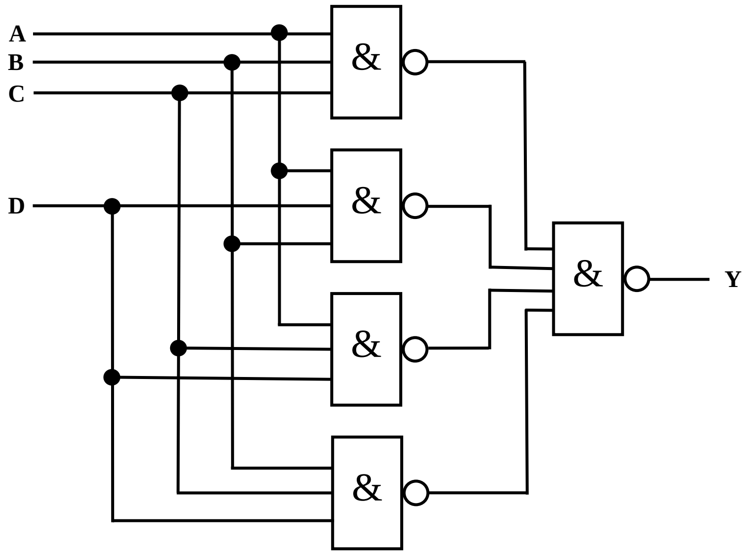


3.11

(1) 真值表为：

S_0	S_1	S_2	S_3	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

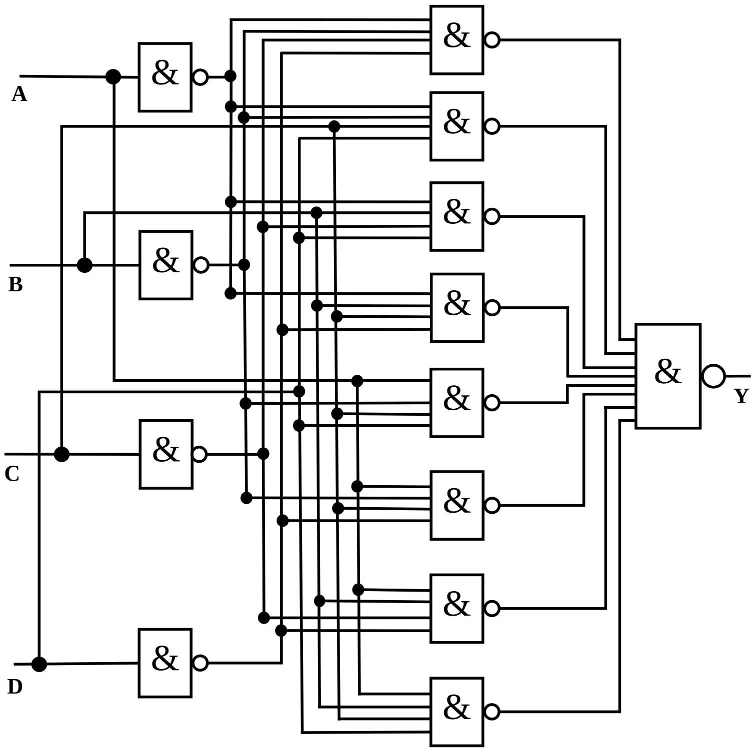
化简得逻辑函数表达式为：$Y = \overline{\overline{BCD} \cdot \overline{ACD} \cdot \overline{ABD} \cdot \overline{ABC}}$



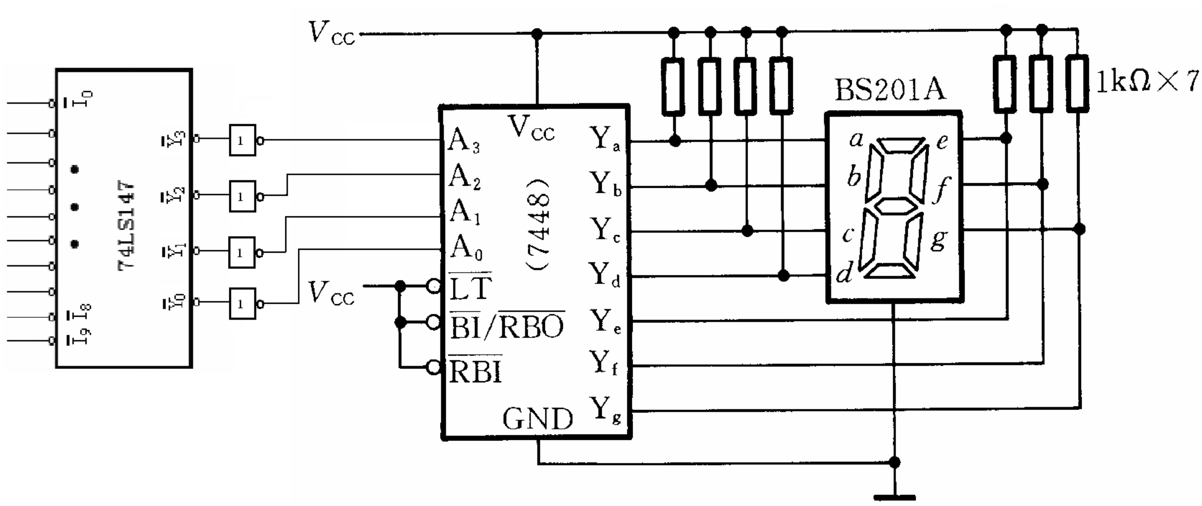
(2) 真值表为:

S_0	S_1	S_2	S_3	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

化简得逻辑函数表达式为: $Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + ABCD$



3.12



3.15

（1） CC4512 的输出逻辑函数为:

$$
\begin{aligned}
Y = & \bar{A}_2\bar{A}_1\bar{A}_0D_0 + \bar{A}_2\bar{A}_1A_0D_1 + \bar{A}_2A_1\bar{A}_0D_2 + \bar{A}_2A_1A_0D_3 \\
& + A_2\bar{A}_1\bar{A}_0D_4 + A_2\bar{A}_1A_0D_5 + A_2A_1\bar{A}_0D_6 + A_2A_1A_0D_7
\end{aligned}
$$

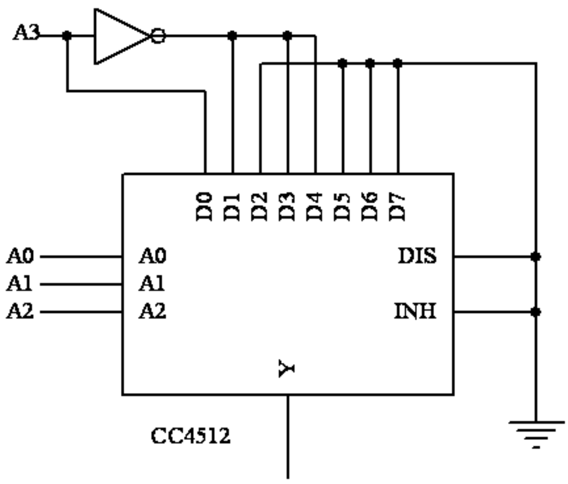
由题意:

$$
\begin{aligned}
Y_1 &= \sum(m1, m3, m4, m8) \\
&= \bar{A}_3\bar{A}_2\bar{A}_1A_0 + \bar{A}_3\bar{A}_2A_1A_0 + \bar{A}_3A_2\bar{A}_1\bar{A}_0 + A_3\bar{A}_2\bar{A}_1\bar{A}_0
\end{aligned}
$$

对比可知:

$$D_1 = D_3 = D_4 = \bar{A}_3, D_0 = A_3, D_2 = D_5 = D_6 = D_7 = 0$$

则电路图为:



（2） CC4512 的输出逻辑函数为:

$$\begin{aligned} Y = &\bar{A}_2\bar{A}_1\bar{A}_0D_0 + \bar{A}_2\bar{A}_1A_0D_1 + \bar{A}_2A_1\bar{A}_0D_2 + \bar{A}_2A_1A_0D_3 \\ &+ A_2\bar{A}_1\bar{A}_0D_4 + A_2\bar{A}_1A_0D_5 + A_2A_1\bar{A}_0D_6 + A_2A_1A_0D_7 \end{aligned}$$

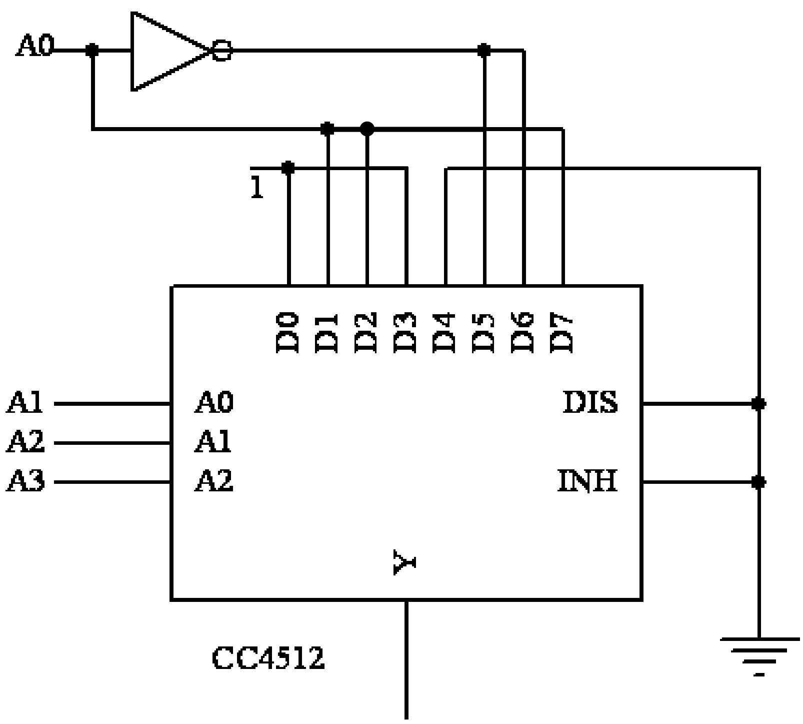
由题意:

$$\begin{aligned} &Y_2 = \sum(m0, m1, m3, m5, m6, m7, m10, m12, m15) \\ &= \bar{A}_3\bar{A}_2\bar{A}_1\bar{A}_0 + \bar{A}_3\bar{A}_2\bar{A}_1A_0 + \bar{A}_3\bar{A}_2A_1A_0 + \bar{A}_3A_2\bar{A}_1A_0 \\ &+ \bar{A}_3A_2A_1\bar{A}_0 + \bar{A}_3A_2A_1A_0 + A_3\bar{A}_2A_1\bar{A}_0 + A_3A_2\bar{A}_1\bar{A}_0 + A_3A_2A_1A_0 \\ &= \bar{A}_3\bar{A}_2\bar{A}_1 + \bar{A}_3\bar{A}_2A_1A_0 + \bar{A}_3A_2\bar{A}_1A_0 + \bar{A}_3A_2A_1 + A_3\bar{A}_2A_1\bar{A}_0 + A_3A_2\bar{A}_1\bar{A}_0 + A_3A_2A_1A_0 \end{aligned}$$

对比可知:

$$D_0 = D_3 = 1, D_1 = D_2 = D_7 = A_0, D_5 = D_6 = \bar{A}_0, D_4 = 0$$

则电路图如下:



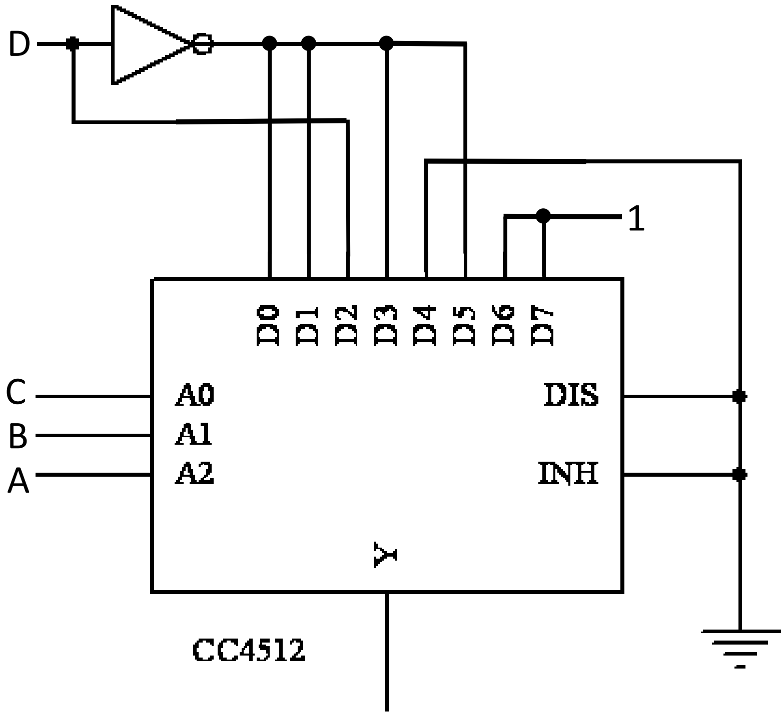
3.16 解：AB 组合四种取值代表“输血者”的四种血型，CD 组合四种取值代表“受血者”的四种血型，组合与血型的对应关系为：$00 \to \mathrm{A}, 1 \to \mathrm{B}, 10 \to \mathrm{AB}, 11 \to 0$ 真值表为：

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

用卡诺图化简得: $Y = AB + C\bar{D} + B\bar{C}D + \bar{A}\bar{B}\bar{D}$
根据 CC4512 的输出逻辑函数，对比可知:

$$D_0 = D_1 = D_3 = D_5 = \bar{D}, D_2 = D, D_4 = 0, D_6 = D_7 = 1$$

则电路图如下:



3.17 设定被水浸过为 1，不浸为 0；灯亮为 1，不亮为 0，则由题意得真值表如下:

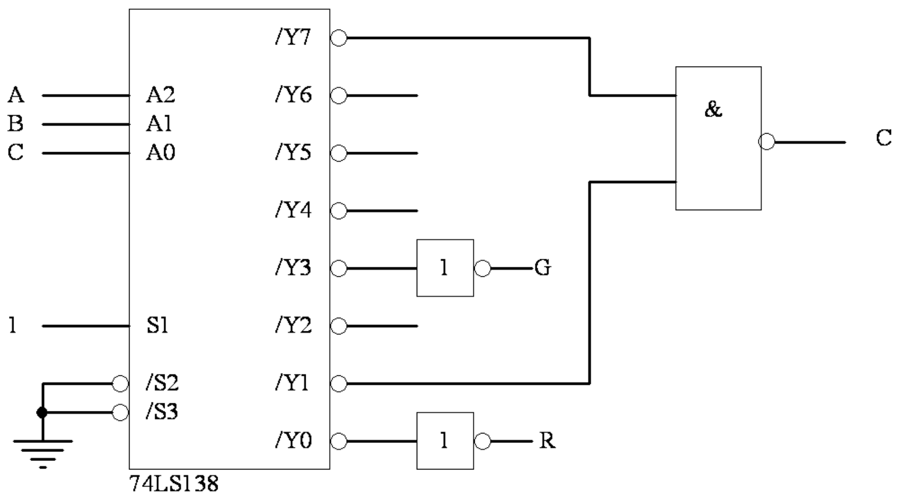
A	B	C	G	Y	R
0	0	0	0	0	1
0	0	0	0	1	0
0	1	0	x	x	x
0	1	1	1	0	0
1	0	0	x	x	x
1	0	1	x	x	x
1	1	0	x	x	x
1	1	1	0	1	0

利用卡诺图化简得到:
$G = \bar{A}BC$

$Y = \bar{A}\bar{B}C + ABC$

$R = \bar{A}\bar{B}\bar{C}$

则电路图如下:



3.18 (1)74LS151 的输出函数为:

$$W = \bar{A}_2\bar{A}_1\bar{A}_0D_0 + \bar{A}_2\bar{A}_1A_0D_1 + \bar{A}_2A_1\bar{A}_0D_2 + \bar{A}_2A_1A_0D_3$$
$$+ A_2\bar{A}_1\bar{A}_0D_4 + A_2\bar{A}_1A_0D_5 + A_2A_1\bar{A}_0D_6 + A_2A_1A_0D_7$$

则由题图可得:

$$Y = \bar{A}\bar{B}\bar{C}\cdot 0 + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}\cdot 1 + A\bar{B}C\bar{D} + AB\bar{C}D + ABC\cdot 1$$
$$= \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C} + A\bar{B}C\bar{D} + AB\bar{C}D + ABC$$

真值表为:

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

$Y = \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}D + ABCD + ABC\bar{D}$

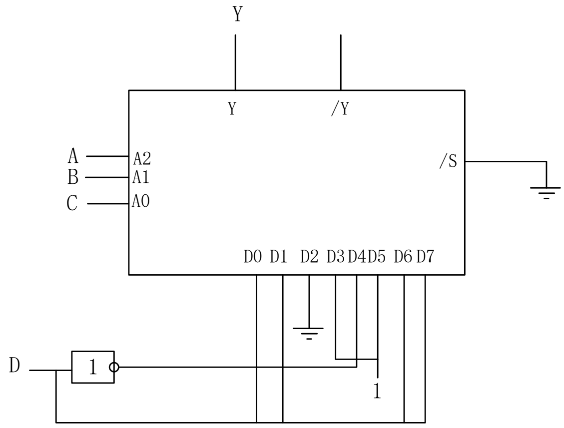
$= \sum(m3, m5, m6, m8, m9, m10, m13, m14, m15)$

$(2) Y = \sum(m1, m3, m6, m7, m8, m10, m11, m13, m15) = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}D + ABCD = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}BC + A\bar{B}\bar{C}\bar{D} + A\bar{B}C + AB\bar{C}D + ABCD$

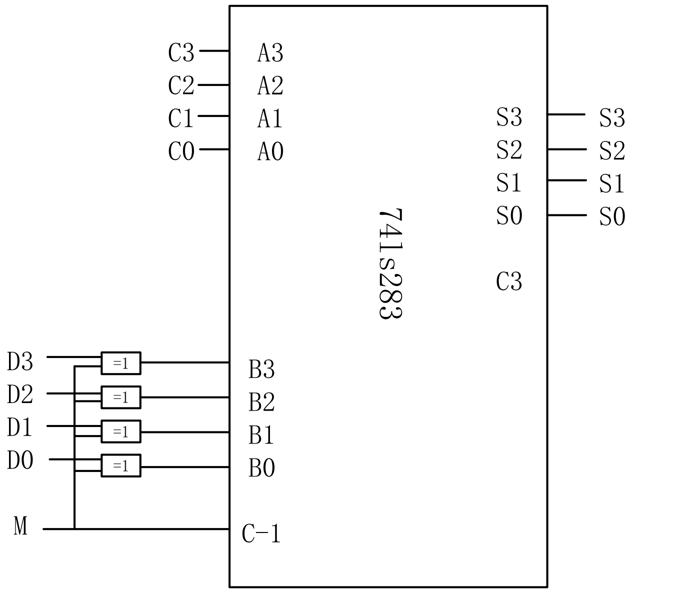
以 A B C 为为输入端, D 为数据输入端令

$A_2 = A, A_1 = B, A_0 = C$ $D_0 = D_1 = D_6 = D_7 = D, D_2 = 0, D_3 = D_5 = 1, D_4 = \bar{D}$

得到电路图如下:



3.19 加法器制作加法, 相减用补码运算 (相加减的为两个正数)。设被减数为 $C = C_3C_2C_1C_0$, 减数为 $\mathrm{D} = \mathrm{D}_3\mathrm{D}_2\mathrm{D}_1\mathrm{D}_0$, 相减时 D 取补码, 补码 = 反码 +1 。CI 输入 M, M = 0 时, D 取原码和 C 相加; M = 1 时, D 取反码, 再加上 CI = 1 正好为补码, 和 C 相加即可。S 为和。当 M = 0 时 C0 为进位; 当 M = 1 时 C0 的反为符号位。所以, 有, 输入端: $\mathrm{A}_3 = \mathrm{C}_3$, $\mathrm{A}_2 = \mathrm{C}_2$, $\mathrm{A}_1 = \mathrm{C}_1$, $\mathrm{A}_0 = \mathrm{C}_0$, CI = M $B_3 = \bar{M}D_3 + M\bar{D}_3$, $B_2 = \bar{M}D_2 + M\bar{D}_2$, $B_1 = \bar{M}D_1 + M\bar{D}_1$, $B_0 = \bar{M}D_0 + M\bar{D}_0$ 输出端: $\mathrm{Y} = \mathrm{Y}_3\mathrm{Y}_2\mathrm{Y}_1\mathrm{Y}_0$ 进位输出或者符号位: $Z = M \oplus CO$

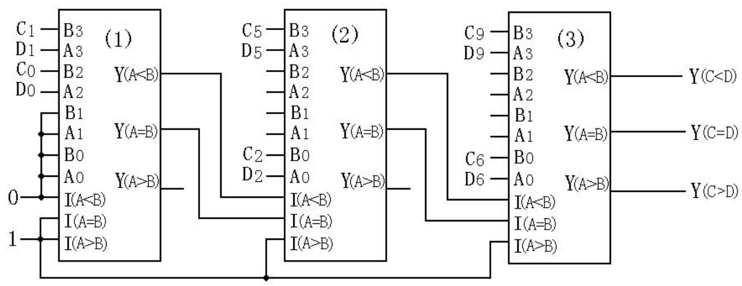


3.22

$Y=\bar{Z}_2\bar{Z}_1\bar{Z}_0\bar{Y}_0+\bar{Z}_2\bar{Z}_1Z_0\bar{Y}_1+\bar{Z}_2Z_1\bar{Z}_0\bar{Y}_2+\bar{Z}_2Z_1Z_0\bar{Y}_3+Z_2\bar{Z}_1\bar{Z}_0\bar{Y}_4+Z_2\bar{Z}_1Z_0\bar{Y}_5+Z_2Z_1\bar{Z}_0\bar{Y}_6+Z_2Z_1Z_0\bar{Y}_7=$
$\bar{Z}_2\bar{Z}_1\bar{Z}_0\overline{\bar{X}_2\bar{X}_1\bar{X}_0}+\bar{Z}_2\bar{Z}_1Z_0\overline{\bar{X}_2\bar{X}_1X_0}+\bar{Z}_2Z_1\bar{Z}_0\overline{\bar{X}_2X_1\bar{X}_0}+\overline{Z_2}Z_1Z_0\overline{\bar{X}_2X_1X_0}+Z_2\bar{Z}_1\bar{Z}_0\overline{X_2\bar{X}_1\bar{X}_0}+Z_2\bar{Z}_1Z_0\overline{\bar{X}_2\bar{X}_1X_0}+$
$Z_2Z_1\bar{Z}_0\overline{X_2X_1\bar{X}_0}+Z_2Z_1Z_0\overline{X_2X_1X_0}$

可见, 本电路完成用 $Z_2Z_1Z_0$ 选择 $X_2X_1X_0$ 的最小项或其反变量的功能。

3.23 需用 3 片，连接有多种方式，其中一种如下: $C=C_9C_8,...,C_0$, $D=D_9D_8,...,D_0$



3.24 由图得到的输出逻辑式为: $Y=\overline{A}CD+A\overline{B}D+B\overline{C}+C\overline{D}$

(1) 当 $B=0,C=D=1$ 时, 输出逻辑式化简为 $Y=A+\overline{A}$, 故 A 改变状态时存在竞争-冒险现象.

(2) 当 $A=1,C=0,D=1$ 时, 输出逻辑式化简为 $Y=B+\overline{B}$, 故 B 改变状态时存在竞争-冒险现象.

(3) 当 $A=0,B=D=1$ 时, 或者当 $A=*,B=1,D=0$ 时, 输出逻辑式化简为 $Y=C+\overline{C}$, 故 C 改变状态时存在竞争-冒险现象.

(4) 当 $A=1,B=0,C=1$ 时, 或者当 $A=0,B=*,C=1$ 时, 输出逻辑式化简为 $Y=D+\overline{D}$, 故 C 改变状态时存在竞争-冒险现象.

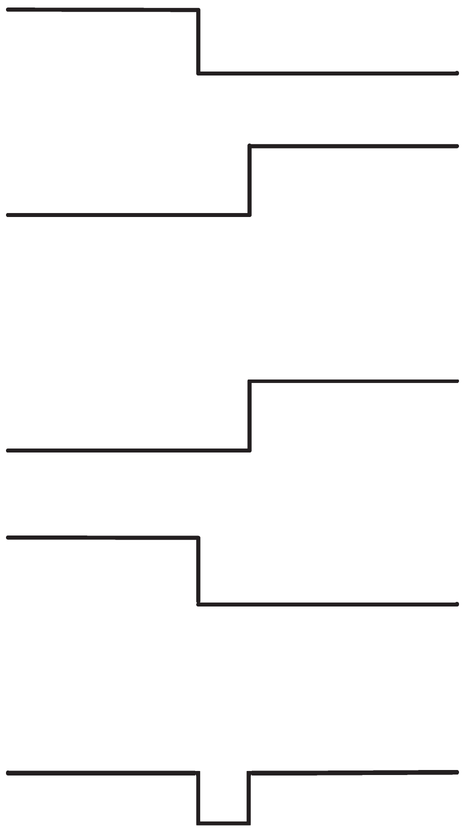
3.25

(1) $F_1 = \overline{CD}, F_2 = \overline{AB\overline{C}}, Y = \overline{\overline{CD} \cdot \overline{AB\overline{C}}} = CD + AB\overline{C}$

当 $D = B = A = 1$, C 发生跳变时, 各点逻辑函数如下:

$F_1 = \overline{C}$, $F_2 = C$, $Y = C + \overline{C}$

波形图如下:



(2) 由图得到逻辑表达式: $Y = \overline{\overline{CD} \cdot \overline{AB\overline{C}}} = CD + AB\overline{C}$

当 $D = B = A = 1$ 时, $Y = C + \overline{C}$, 则有可能有竞争冒险.

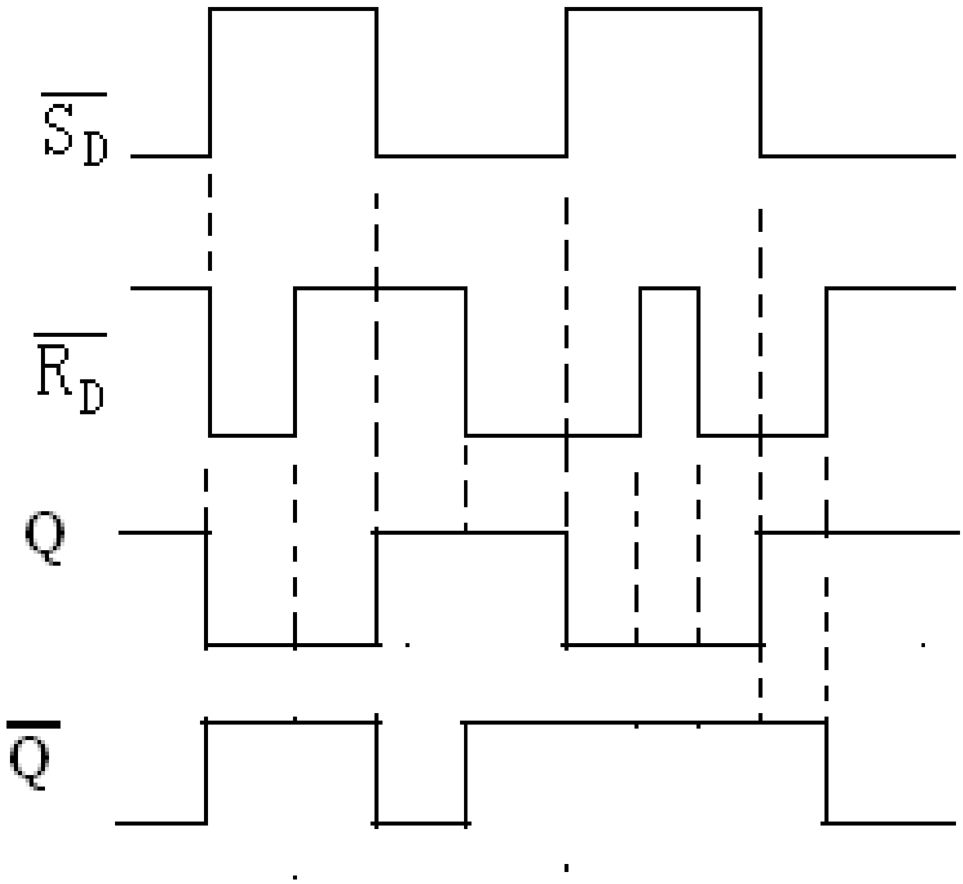
(3) 加入冗余项:

$Y = CD + AB\overline{C} = CD + AB\overline{C} + ABD.$

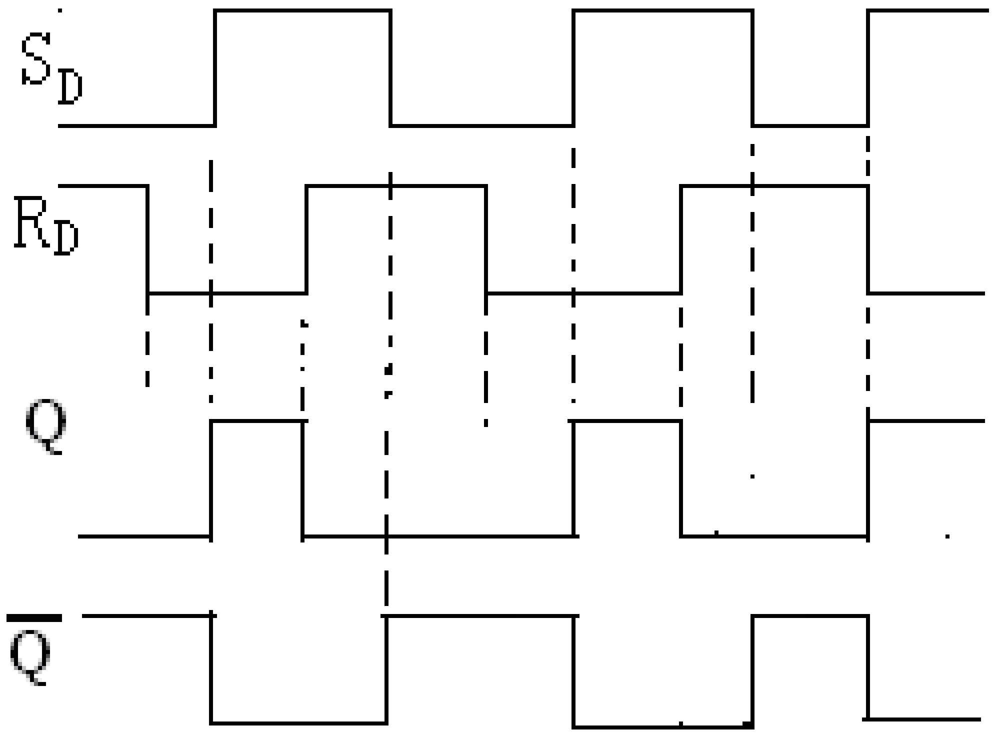
电路修改略

4 触发器

4.4

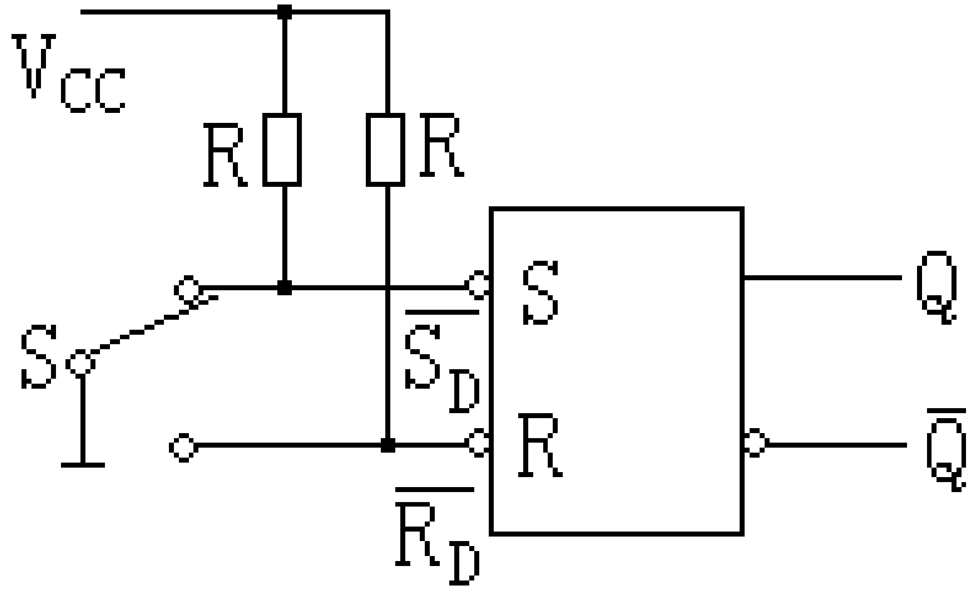


4.5

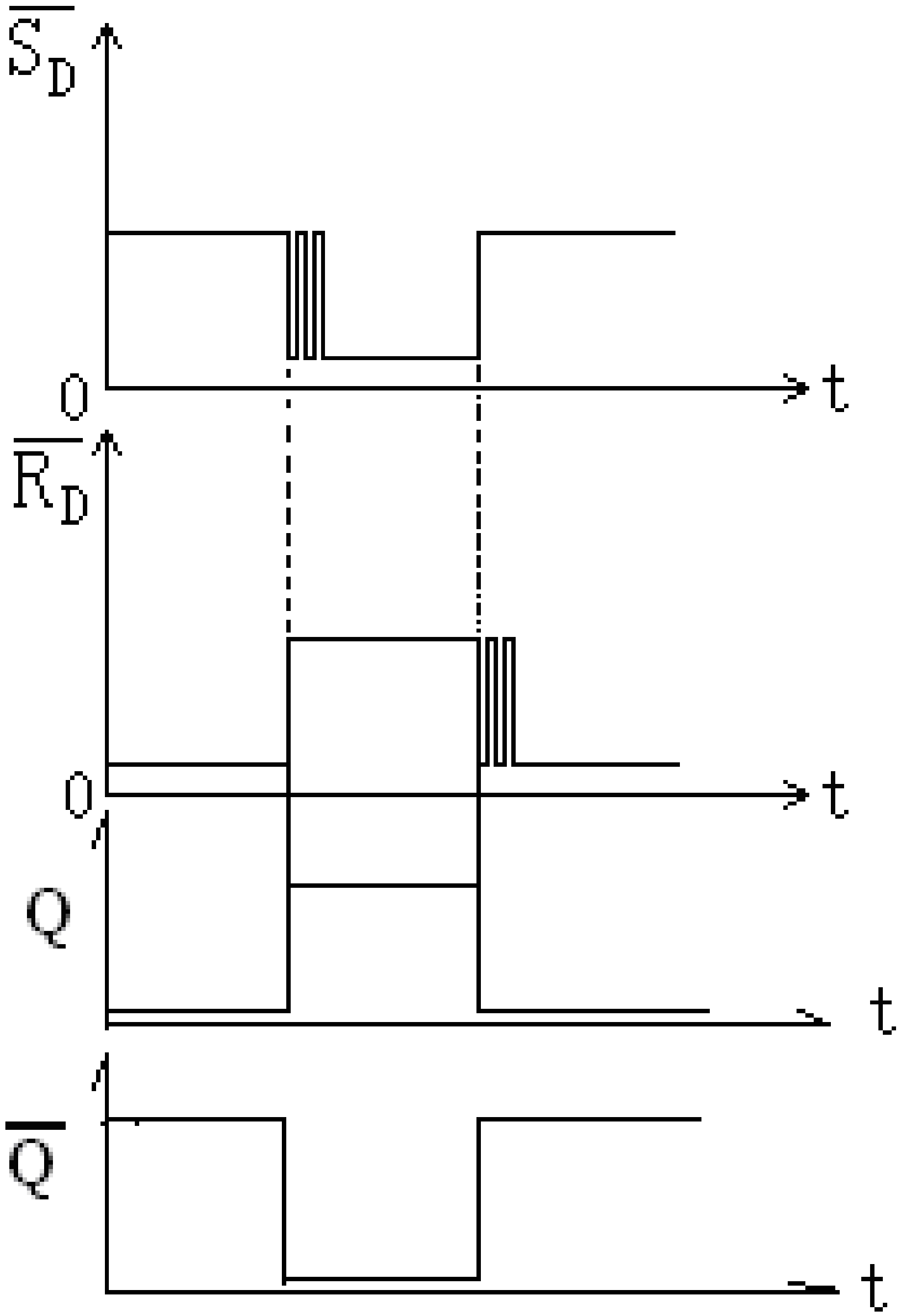


S_D
R_D
Q
$\overline{Q}$

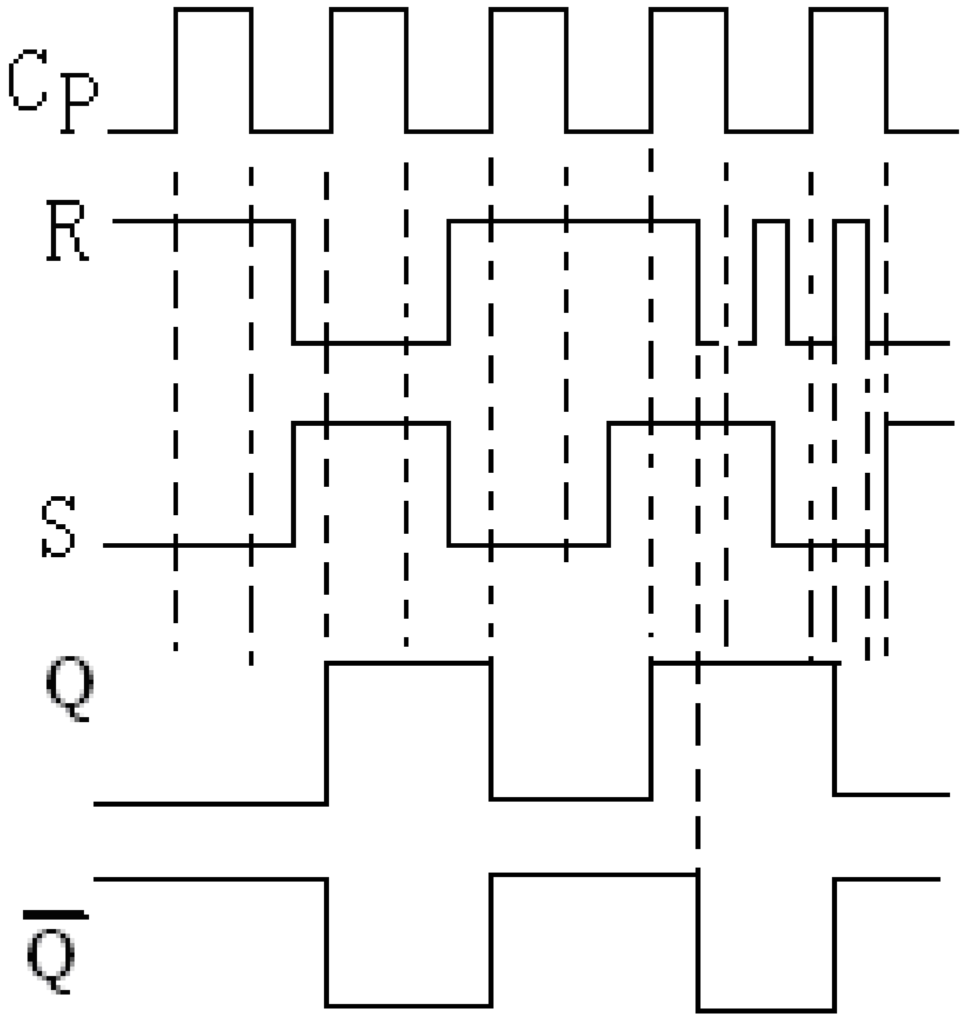
4.6



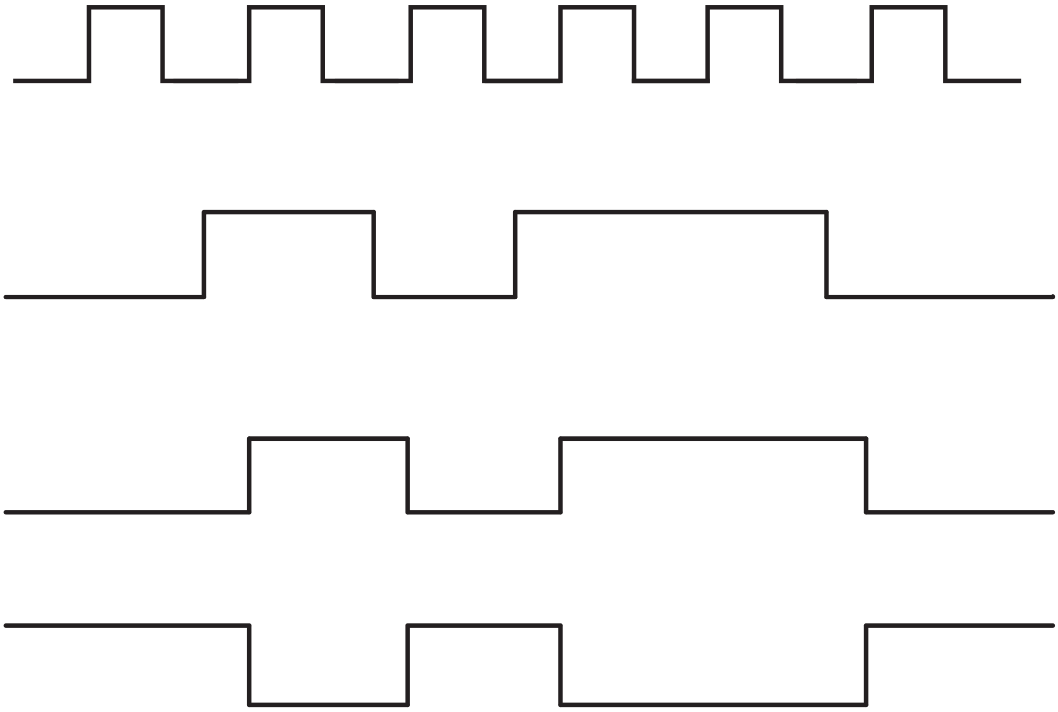
V_{CC}
R
R
S
S
R
$\overline{S_D}$
$\overline{R_D}$
Q
$\overline{Q}$



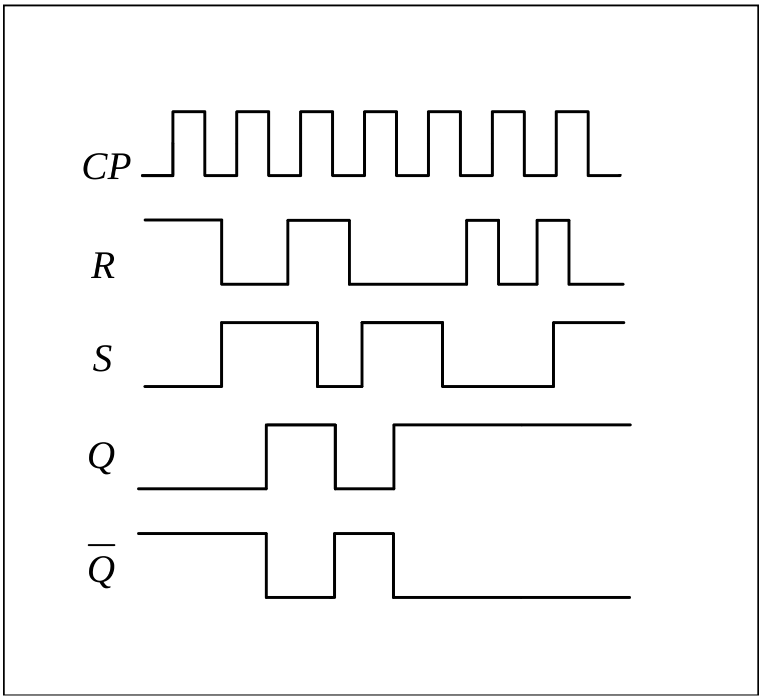
4.7



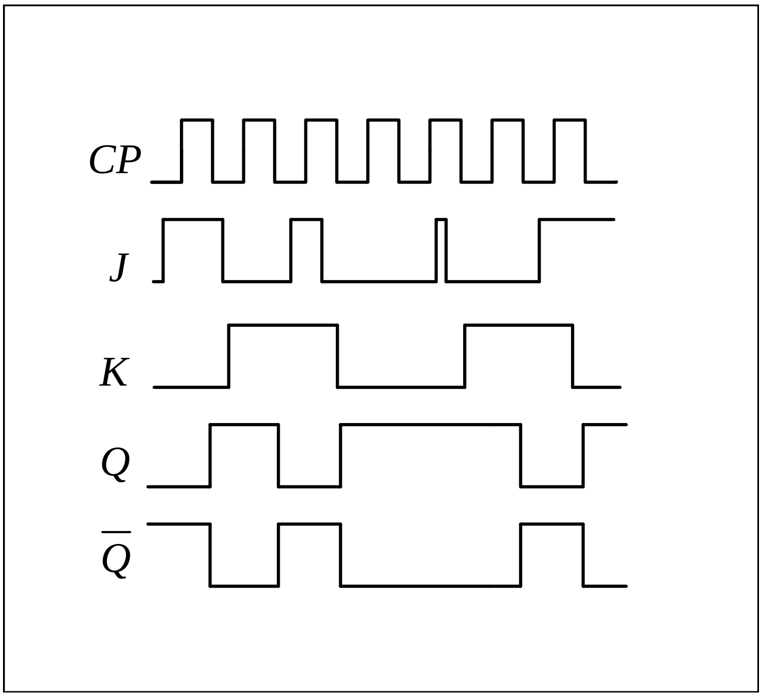
4.8



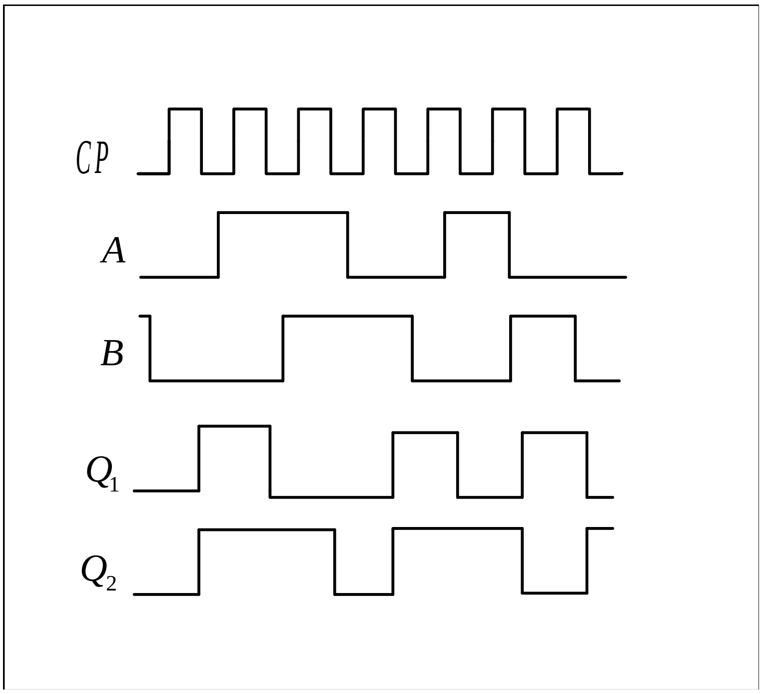
4.9



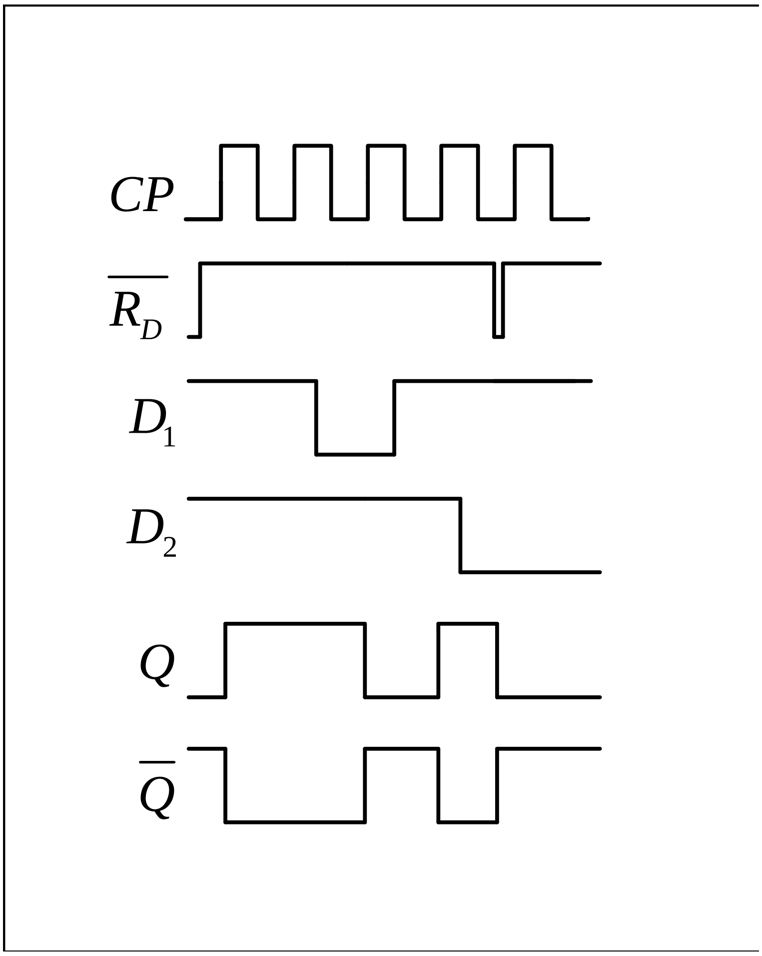
4.10



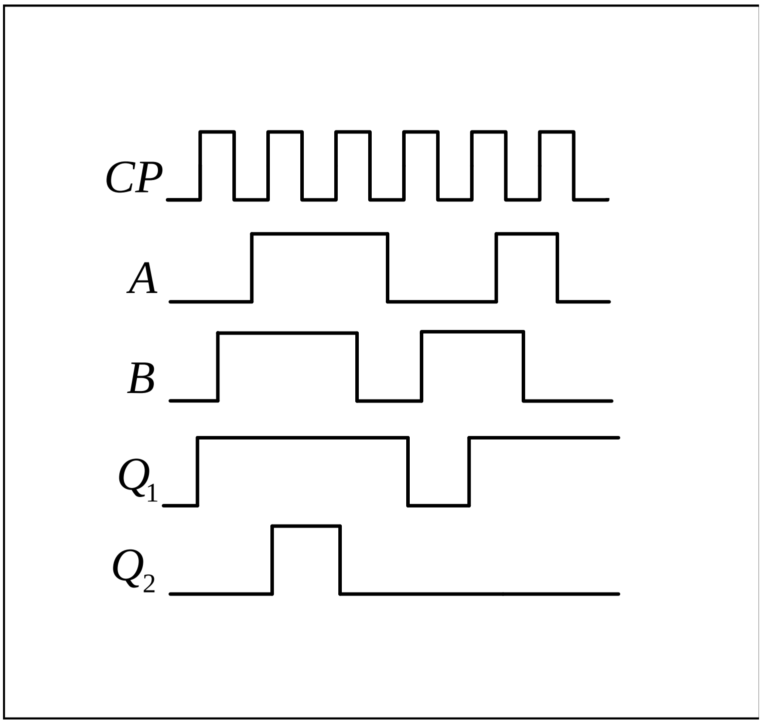
4.11



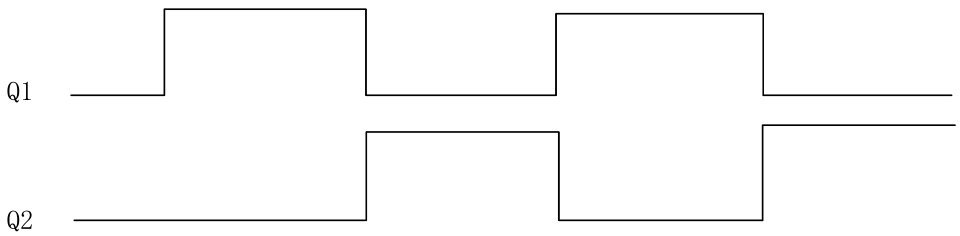
4.13



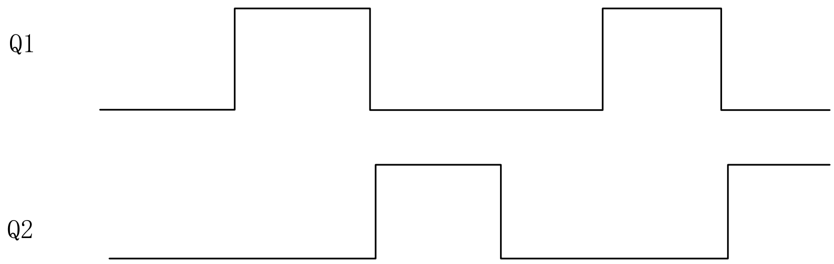
4.14



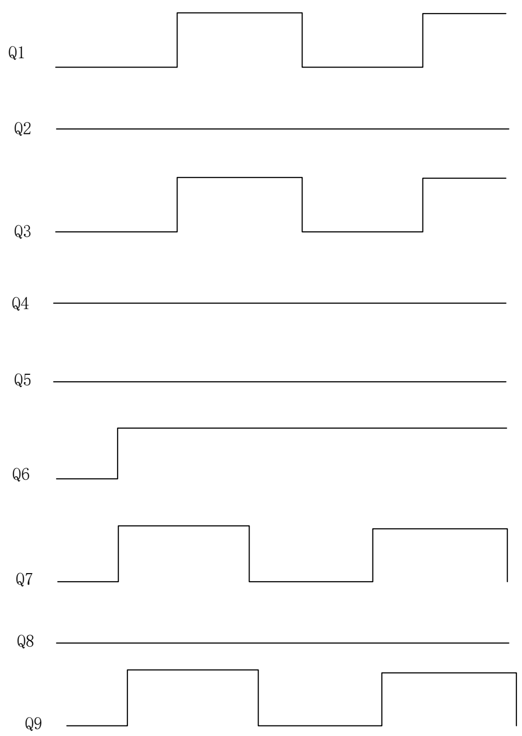
4.15



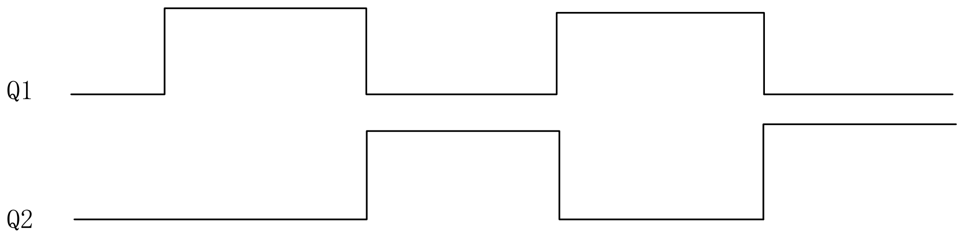
4.16



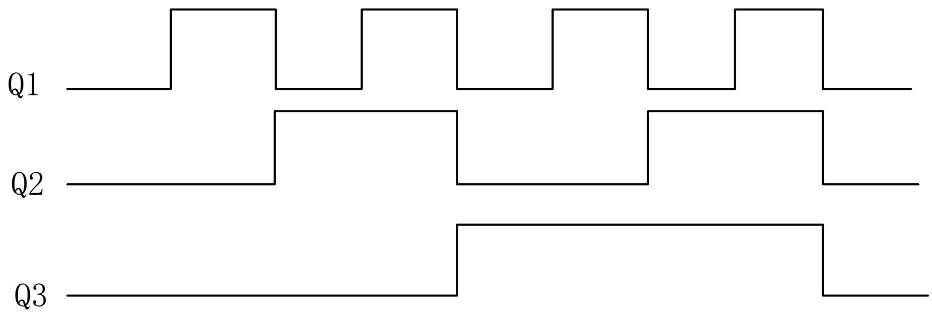
4.17



4.18



4.20



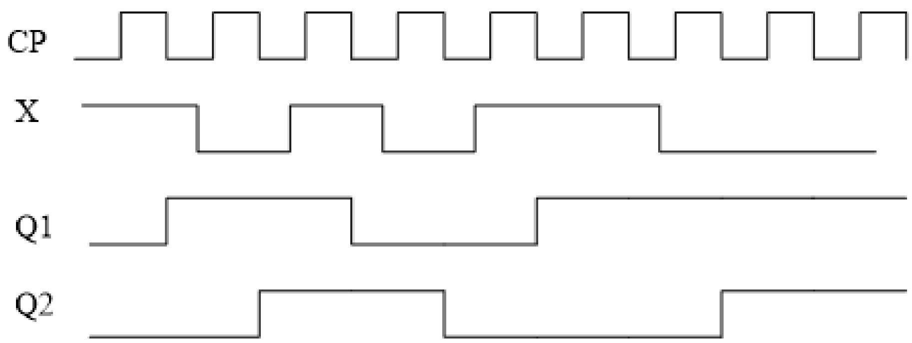
5 时序逻辑电路分析与设计

5.5

$J_1 = X\bar{Q}_2, K_1 = XQ_2 \therefore Q_1^{n+1} = X \bullet \bar{Q}_1 \bullet \bar{Q}_2 + \overline{XQ_2}Q_1 = X \bullet \bar{Q}_2 + \bar{X}Q_1 + Q_1 \bullet \bar{Q}_2$

$J_2 = \bar{X}Q_1, K_2 = \bar{X} \bullet \bar{Q}_1 \therefore Q_2^{n+1} = \bar{X}Q_1 \bullet \bar{Q}_2 + \overline{\bar{X} \bullet \bar{Q}_1}Q_2 = \bar{X} \bullet Q_1 + XQ_2 + Q_1 \bullet Q_2 = Z$

下降沿触发



5.6

$J_1 = \bar{Q}_3, K_1 = 1, \therefore Q_1^{n+1} = \bar{Q}_1 \bullet \bar{Q}_3$

$J_2 = K_2 = Q_1, \therefore Q_2^{n+1} = Q_1 \oplus Q_2$

$J_3 = Q_1Q_2, K_3 = 1, \therefore Q_3^{n+1} = Q_1Q_2 \bullet \bar{Q}_3$

状态转换表为:

Q_3^n	Q_2^n	Q_1^n	Q_3^{n+1}	Q_2^{n+1}	Q_1^{n+1}	C
0	0	0	0	0	1	0
0	0	1	0	1	0	0
0	1	0	0	1	1	0
0	1	1	1	0	0	0
1	0	0	0	0	0	1

(15)

由状态转换表可知，该时序电路的功能为 5 进制转换器

5.7

控制函数:

$D_0 = Q_0 + \overline{X}Y\overline{Q_1}$

$D_1 = Q_1 + X\overline{Y}\overline{Q_0}$

输出函数:

$L = Q_0^{n+1}, G = Q_1^{n+1}, E = \overline{Q_1^{n+1} + Q_0^{n+1}}$

状态方程:

$Q_0^{n+1} = Q_0^n + \overline{X}Y\overline{Q_1^n}$

$Q_1^{n+1} = Q_1^n + X\overline{Y}\overline{Q_0^n}$

状态转化表酌情给分.

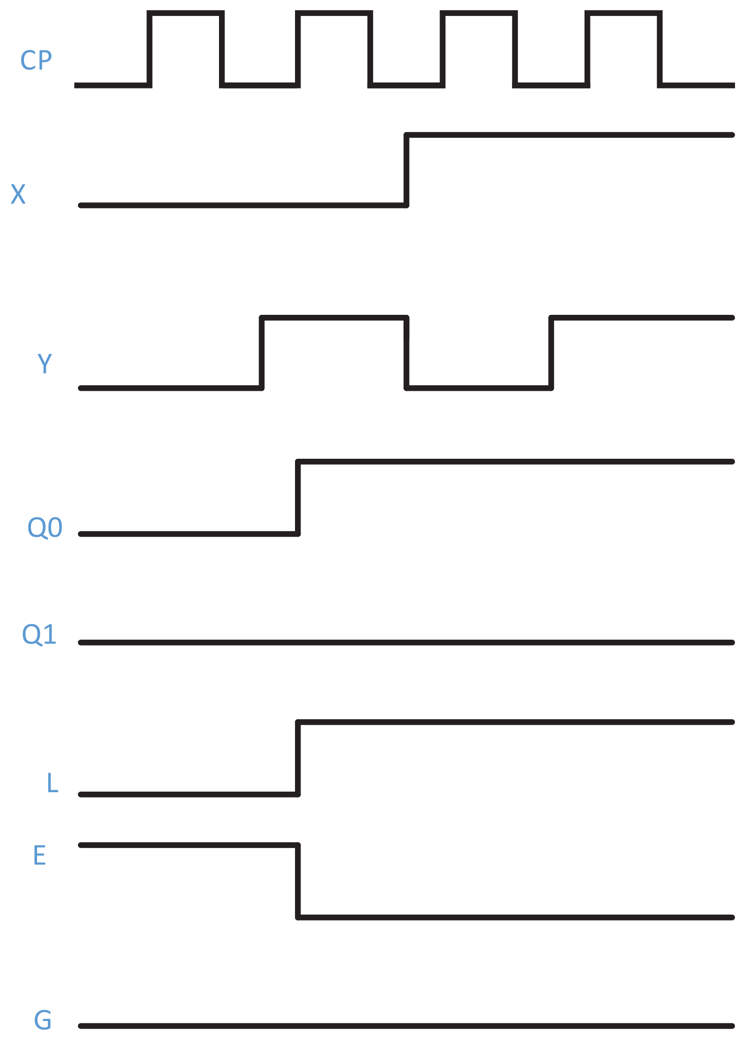
状态转移图酌情给分.

功能分析:

Q_1Q_0 为 00 且 $X=Y=1$ 时, $E=1$, 等待" 清零".

Q_1Q_0 为 11 时, 无论 X, Y, 次态均为 11, 无法自启动, 等待" 清零".

其他情况下, $XY=01/10$ 时, 次态与 XY 相同.



5.11

74163 是同步清零同步置数的四位二进制计数器, 只有 $S0$ 时 Z 为 0, 所以 $Z = Q_2 + Q_1 + Q_0$.

$D2D1D0/\overline{LD}$	00	01	11	10
000	000/0	100/0	X	$X/1$
001	X/1	X	X	001/0
011	000/0	011/0	X	X
010	010/0	X/1	X	X
110	000/0	X	X	110/0
111	X	X	X	X
101	101/0	X/1	X	X/1
100	X/1	100/0	X	X

(16)

$\overline{LD} = Q_2\overline{Q_1Q_0X_0} + \overline{Q_1Q_0}X_1 + \overline{Q_2Q_1}Q_0\overline{X_1} + Q_2\overline{Q_1}X_1$

$D_2 = Q_2\overline{Q_1} + Q_2X_1 + \overline{Q_1}X_0$

$D_1 = \overline{Q_2}Q_1\overline{Q_0} + Q_1X_0 + Q_1X_1$

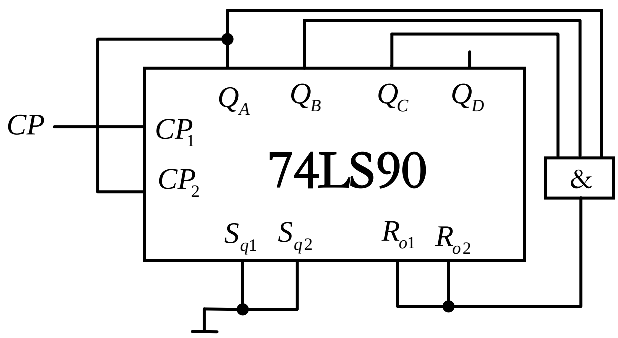
$D_0 = Q_2\overline{Q_1}Q_0 + Q_0X_1 + Q_0X_0$

$D_3 = 0$

按照表达式就可以画出电路图（略）

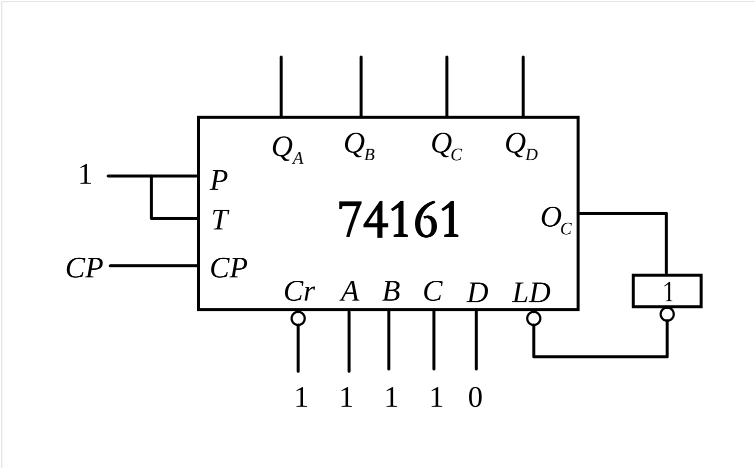
5.13

答案不唯一，下图为异步清 0，先连成 10 进制，当输出为 0111 清 0。

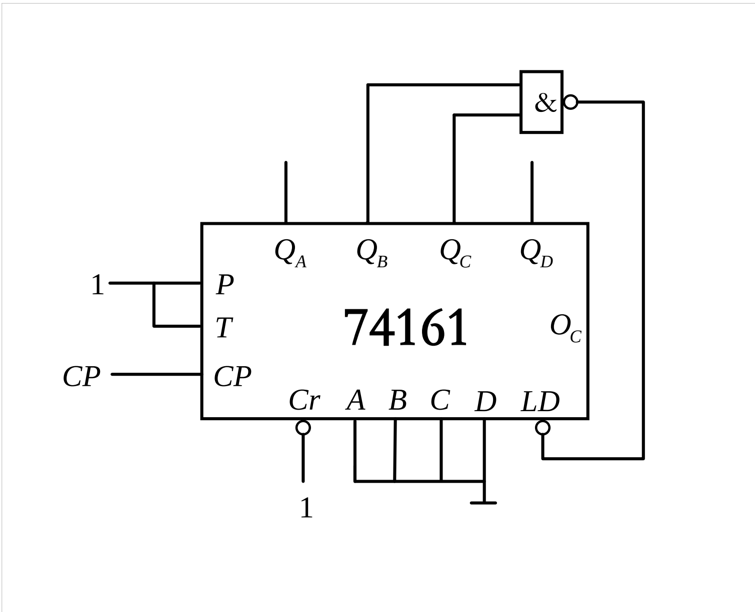


5.14

异步清 0 电路图为:

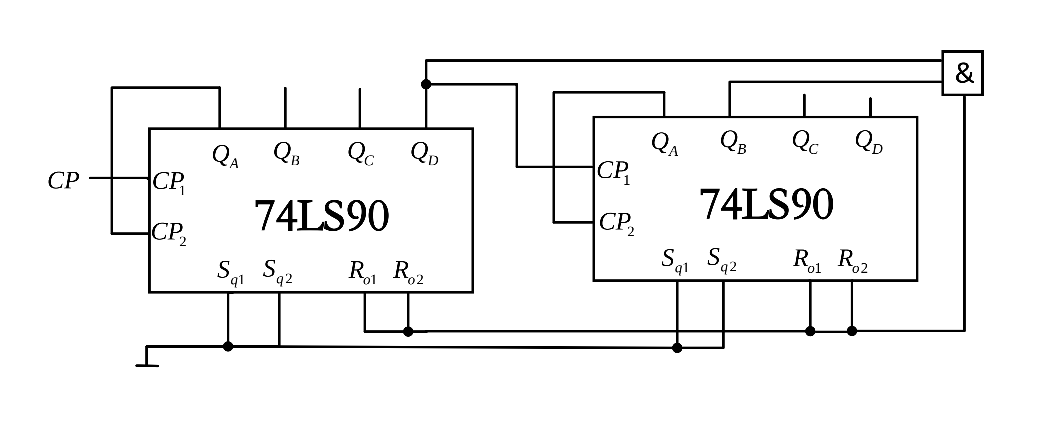


同步置 0 电路图为：



5.15

答案不唯一。因一片 74LS90 的最大计数值为 10，故实现模 40 计数器需要两片 74LS90 计数器。此答案先将两片 74LS90 用 8421BCD 码接法构成模 100 计数器，然后加译码反馈器构成模 40 计数器，过渡态为 00101000。电路图如下图所示：



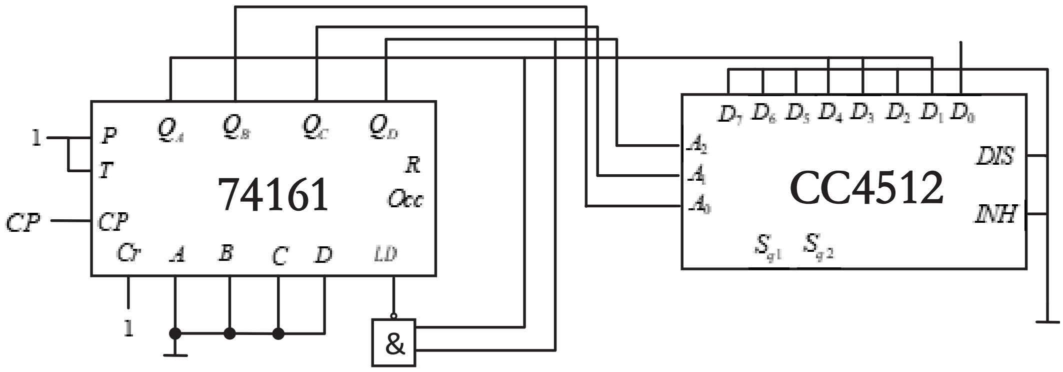
5.17 图中为整体同步置数，所以置数变化为 11111111–X。
M=100 时，预置值 10011100,
M=200 时，预置值 00111000,
M=152。

5.18
序列信号 1101000101 共 10 位, 故将 74161 改造为模 10 计数器, 采用同步预置法. 当 $Q_DQ_CQ_BQ_A = 1001$ 时, 同步预置信号激活, 即 $LD = \overline{Q_DQ_A}$(低电平有效), 则电路状态表如下:

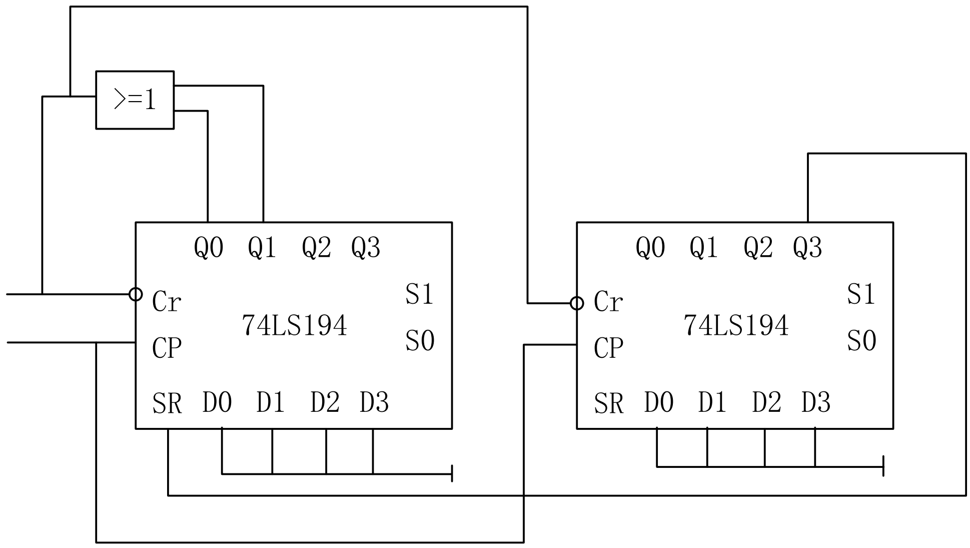
Q_D	Q_C	Q_B	Q_A	Y
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1

(17)

则 $D_0 = 1, D_1 = D_3 = D_4 = Q_A, D_2 = D_5 = D_6 = D_7 = 0$, $A_2 = Q_D, A_1 = Q_c, A_0 = Q_B$.
电路图如下



5.19 答案不唯一，采用两片 194 为比较简便做法，也可直接用三片 194 实现。



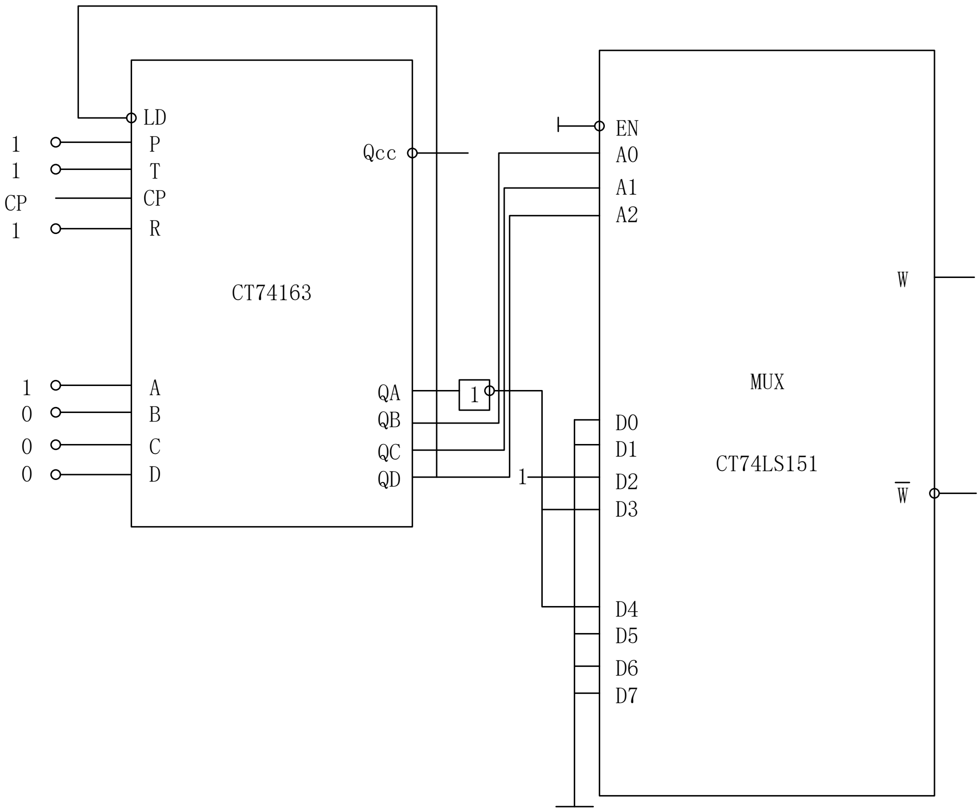
5.20 序列长度为 8，设计 M=8 计数器，选用 CT74163。则有

$$Z = \overline{Q_D}\bar{Q}_C\overline{Q_B} + \overline{Q_D}Q_CQ_B\overline{Q_A} + Q_D\overline{Q_CQ_BQ_A}$$

$Q_DQ_CQ_B = A_2A_1A_0, D_T = f(Q_A)$

$Z = \bar{A}_2A_1\overline{AO}_0D_2 + \overline{A_2A_1}A_0D_3 + \overline{A_2}A_1A_0D4$

$D_2 = 1, D_3 = D_4 = \overline{Q_A}, D_0 = D_1 = D_5 = D_6 = D_7 = 0$



5.21

$Q_3Q_2 \vert Q_1Q_0$	00	01	11	10
00	1001	0000	0010	0001
01	0011	0100	0110	0101
11	X	X	X	X
10	0111	1000	X	X

(18)

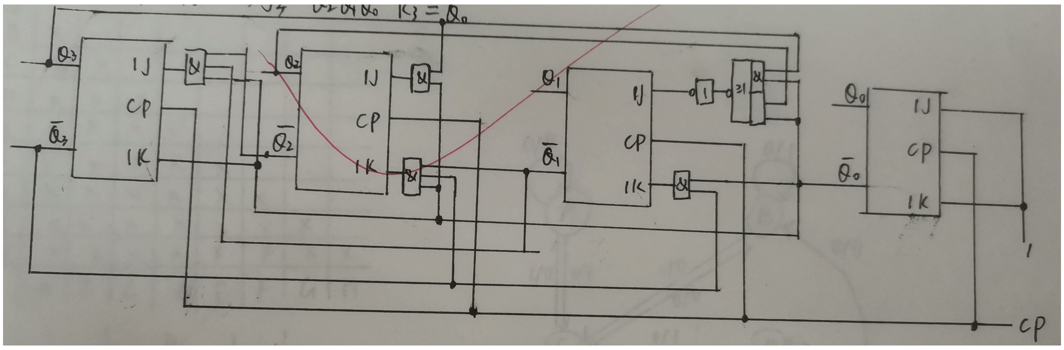
$Q_3^{n+1} = \overline{Q_1 Q_0} Q_3 \overline{Q_0} + Q_3 Q_0$, $J_3 = \overline{Q_2 Q_1 Q_0} + Q_3 Q_0$, $K_3 = \overline{Q_0}$.

$Q_2^{n+1} = Q_3 \overline{Q_0} + Q_2 Q_0 + Q_2 Q_1$, $J_2 = Q_3 \overline{Q_0}$, $K_2 = \overline{Q_3 \overline{Q_0} + Q_0 + Q_1} = \overline{Q_3 Q_0 Q_1}$.

$Q_1^{n+1} = Q_1 Q_0 + Q_2 \overline{Q_1 Q_0} + Q_3 \overline{Q_0}$, $J_1 = Q_2 \overline{Q_0} + Q_3 \overline{Q_0}$, $K_1 = \overline{Q_3 \overline{Q_0} + Q_0} = \overline{Q_3 Q_0}$.

$Q_0^{n+1} = \overline{Q_0}$, $J_0 = K_0 = 1$.

根据表达式画图.



5.22 状态表为

	0	1
S0	S0/0	S1/0
S1	S2/0	S3/0
S2	S4/0	S5/1
S3	S6/1	S7/0
S4	S8/0	S9/0
S5	S10/0	S11/0
S6	S12/0	S13/1
S7	S14/0	S15/0
S8	S0/0	S1/0
S9	S2/0	S3/0
S10	S4/0	S5/1
S11	S6/1	S7/0
S12	S8/0	S9/0
S13	S10/0	S11/0
S14	S12/1	S13/1
S15	S14/0	S15/0

(19)

5.23

a

B	X								
C	X	X							
D	X	X	X						
E	X	X	X	✓					
F	✓	X	X	X	X				(20)
G	X	X	✓	X	X	X			
H	X	✓	X	X	X	X	X		
I	X	X	X	X	X	X	X	X	
	A	B	C	D	E	F	G	H	

	0	1
A	A/0	C/1
B	B/1	C/0
C	B/0	A/0
D	C/1	D/0
I	B/0	D/0

(21)

b

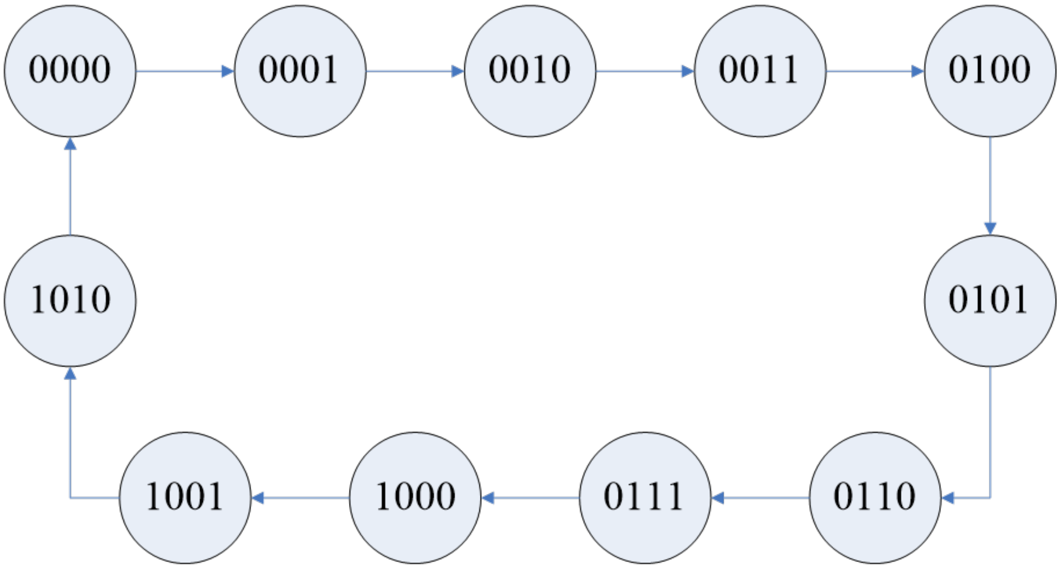
B	X						
C	X	√					
D	X	X	X				
E	X	X	X	X			
F	√	X	X	X	X		
G	X	X	X	X	X	X	
H	X	√	√	X	X	X	X
	A	B	C	D	E	F	G

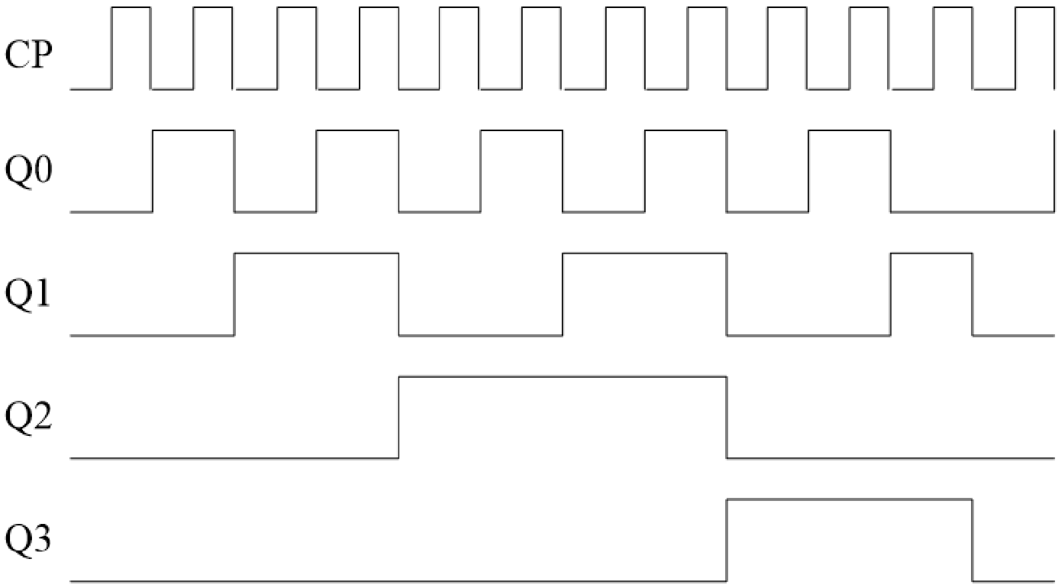
(22)

	00	01	10	11
A	D/0	D/0	A/0	A/0
B	B/1	D/0	A/0	E/1
D	D/0	B/0	A/0	E/1
E	B/1	A/0	A/0	E/1
G	G/0	G/0	A/0	A/0

(23)

5.25 $2^4 \geq 11$, 所以 $N = 4$



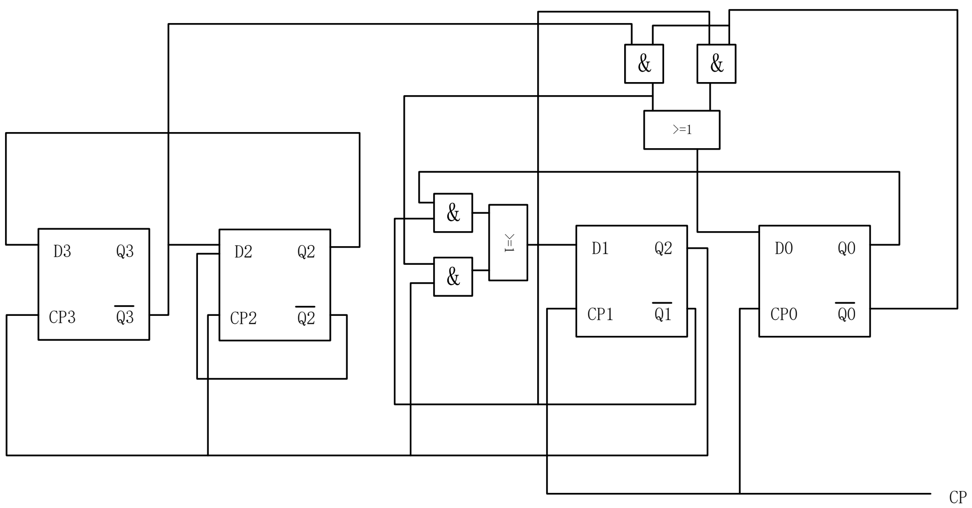


所以, $CP0 = CP, CP1 = CP, CP2 = Q1, CP3 = Q1$

Qn	Qn + 1	D
0000	0001	xx01
0001	0010	xx10
0010	0011	xx11
0011	0100	0100
0100	0101	xx01
0101	0110	xx10
0110	0111	xx11
0111	1000	1000
1000	1001	xx01
1001	1010	xx10
1010	0000	0000

(24)

最终电路如图



6 脉冲波形的产生和整形

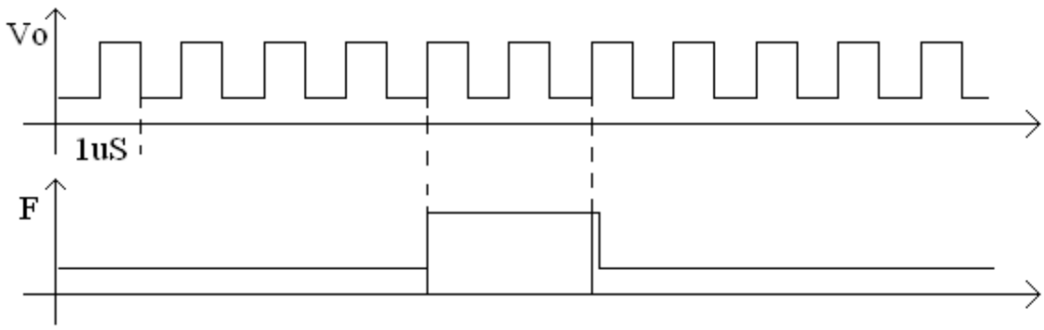
6.5 解: 对于 74 的 TTL 电路, 取 $\mathrm{V_{OH}} = 3$ V, $\mathrm{V_{OL}} = 0$, $\mathrm{V_{TH}} = 1.3$ V, R1 = 4k
由于 $\mathrm{R_1 + R_s >> R}$, 则有:

$$\begin{aligned} T_1 &= RC \ln \frac{2V_{OH} - V_{TH}}{V_{OH} - V_{TH}} = 1.02 \times 10^{-6}\ \mathrm{S} \\ T_2 &= RC \ln \frac{V_{OH} + V_{TH}}{V_{TH}} = 1.20 \times 10^{-6}\ \mathrm{S} \\ f &= \frac{1}{T} = \frac{1}{T_1 + T_2} = 0.45\mathrm{MHz} \end{aligned} \tag{25}$$

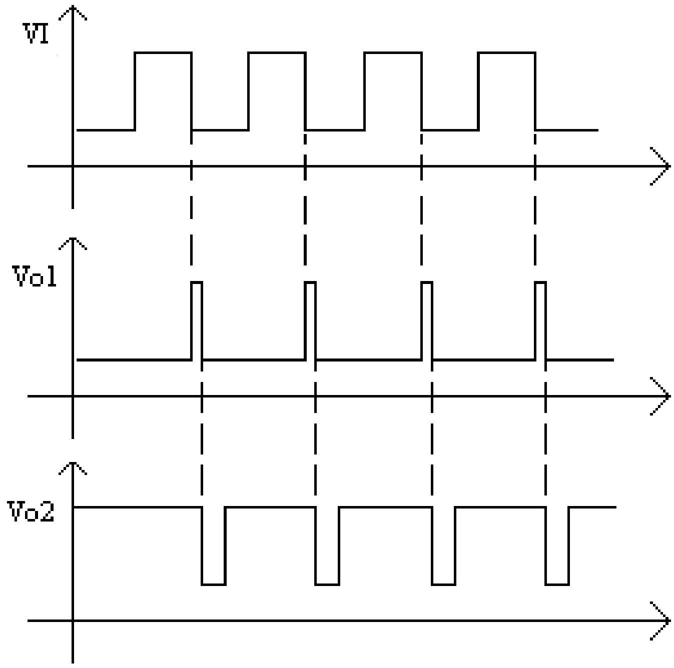
6.6

解: 石英晶体的多谐振器频率为 f = 1MHz 74LS90 为下降沿计数
并由电路可知, 当 QC = 1, QB = 1 即 110 时, 被异步清零。加反相器波形如下（不加反相器下降沿也对）
:

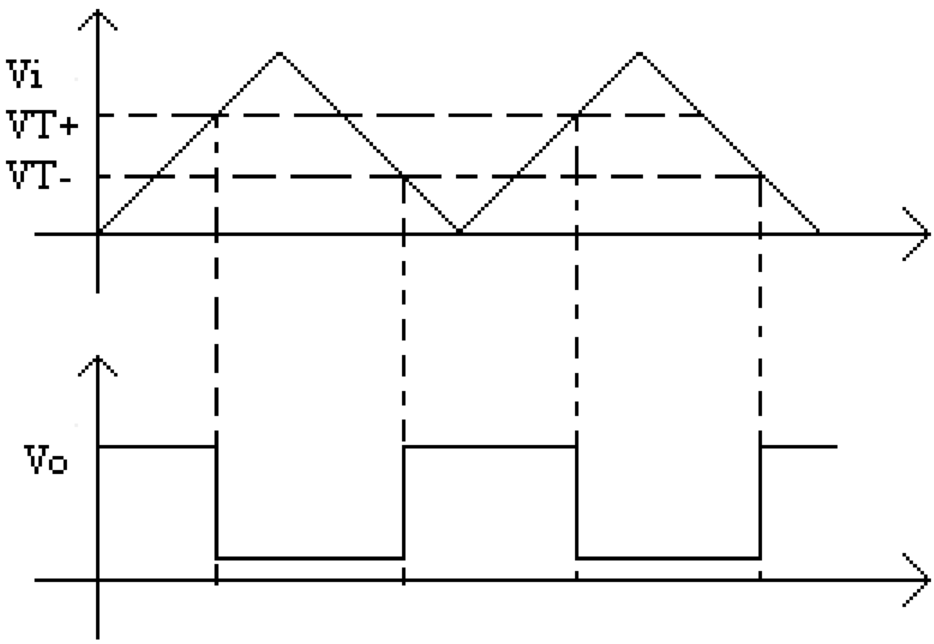
$$f^{'} = \frac{1}{T^{'}} = 1.67 \times 10^{-7} kHz$$



6.7 解: $T_1 = TW_1 = 0.7R_1C_1 = 1ms$, $T_2 = TW_2 = 0.7R_2C_2 = 2ms$



6.8 解:



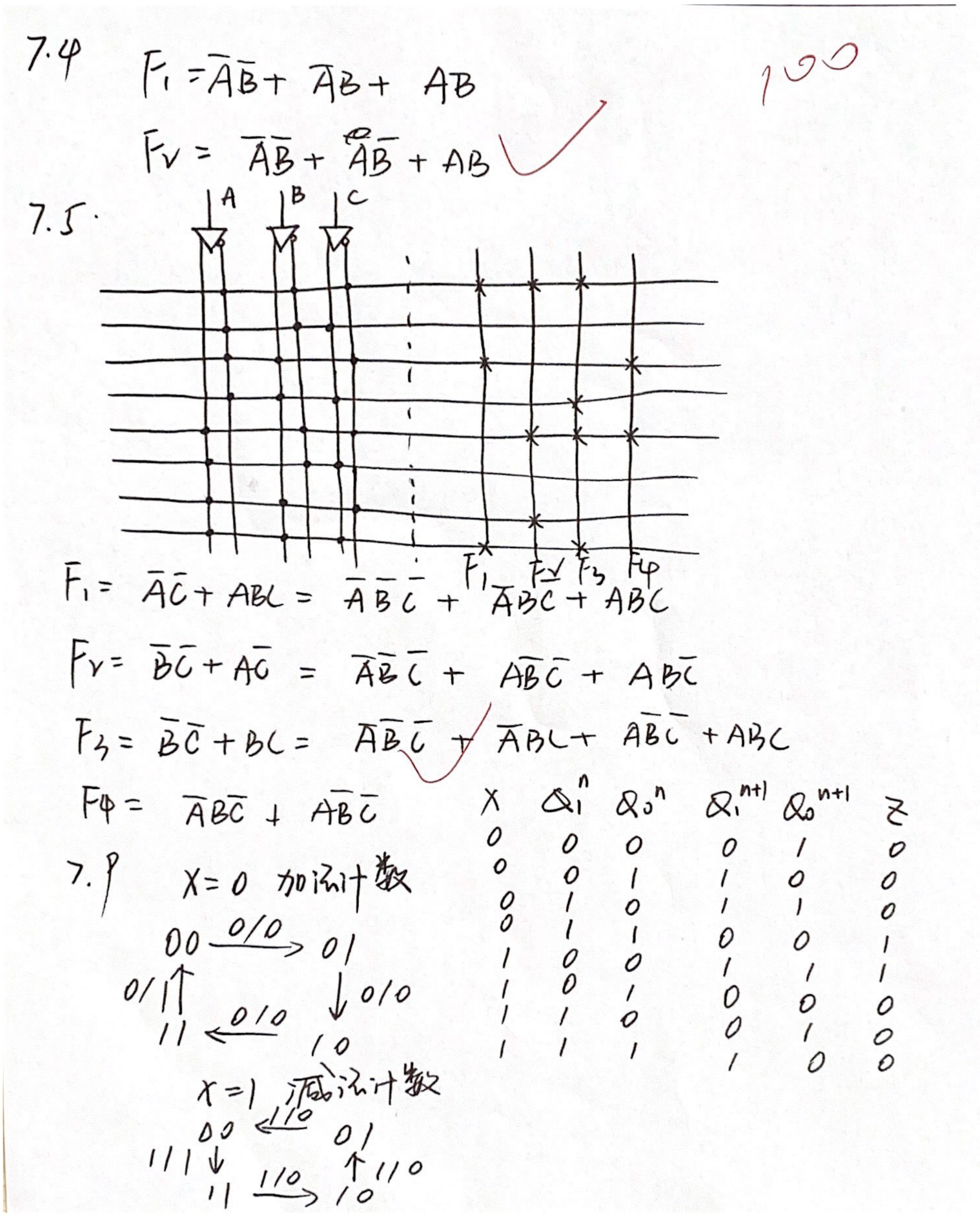
7 数/模和模/数转换

10.2 由于反馈电阻为 $R/2$, 故输出电压 $u_0 = -6.34V$

10.5 ADC 输出为 12 位 2 进制数, 输入信号最大值为 5V.
分辨率为：$1.22mv$.

10.7 双积分型 A/D 转换器完成一次 AD 转换需要 $819200ns$.
逐次逼近型 A/D 转换器完成一次转换大约需要 $1400ns$.

10.8 双积分型 A/D 转换器完成一次 AD 转换需要 $0.02048s$，频率大约为 $48.83Hz$, 小于 $8KHz$, 所以双积分型 A/D 转换器不满足要求。
逐次逼近型 A/D 转换器完成一次 AD 转换需要 $0.000012s$，频率大约为 $8.333KHz$, 大于 $8KHz$, 但是小于 2 倍最大信号频率，所以逐次逼近型 A/D 转换器也不满足要求。



7.4

$F_1 = \bar{A}\bar{B} + \bar{A}B + AB$

$F_2 = \bar{A}\bar{B} + A\bar{B} + AB$

100

7.5

$F_1 = \bar{A}\bar{C} + ABC = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + ABC$

$F_2 = \bar{B}\bar{C} + A\bar{C} = \bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$

$F_3 = \bar{B}\bar{C} + BC = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$

$F_4 = \bar{A}B\bar{C} + A\bar{B}\bar{C}$

7.9

X=0 加法计数

$00 \xrightarrow{0/0} 01$, $01 \xrightarrow{0/0} 10$, $10 \xrightarrow{0/0} 11$, $11 \xrightarrow{0/1} 00$

X=1 减法计数

$00 \xrightarrow{1/1} 11$, $11 \xrightarrow{1/0} 10$, $10 \xrightarrow{1/0} 01$, $01 \xrightarrow{1/0} 00$

X	Q_1^n	Q_0^n	Q_1^{n+1}	Q_0^{n+1}	Z
0	0	0	0	1	0
0	0	1	1	0	0
0	1	0	1	1	0
0	1	1	0	0	1
1	0	0	1	1	1
1	0	1	0	0	0
1	1	0	0	1	0
1	1	1	1	0	0

图 1: 7.4-7.9

Q_1^{n+1}

$X \backslash Q_1^nQ_0^n$	00	01	11	10
0		1		1
1	1		1	

$$Q^{n+1} = (\bar{X}\bar{Q}_0^n + XQ_0^n)Q_1^n + (X\bar{Q}_0^n + \bar{X}Q_0^n)\bar{Q}_1^n$$

Q_0^{n+1}

$X \backslash Q_1^nQ_0^n$	00	01	11	10
0	1			1
1	1			1

$$Q_0^{n+1} = \bar{Q}_0^n$$

Z:

$X \backslash Q_1^nQ_0^n$	00	01	11	10
0			1	
1	1			

$$Z = \bar{X}Q_1^nQ_0^n + X\bar{Q}_1^n\bar{Q}_0^n$$

$$J_1 = X\bar{Q}_0^n + \bar{X}Q_0^n \qquad K_1 = \overline{\bar{X}\bar{Q}_0^n + XQ_0^n} = X\bar{Q}_0^n + \bar{X}Q_0^n$$

$$J_2 = 1 \qquad K_2 = 1$$

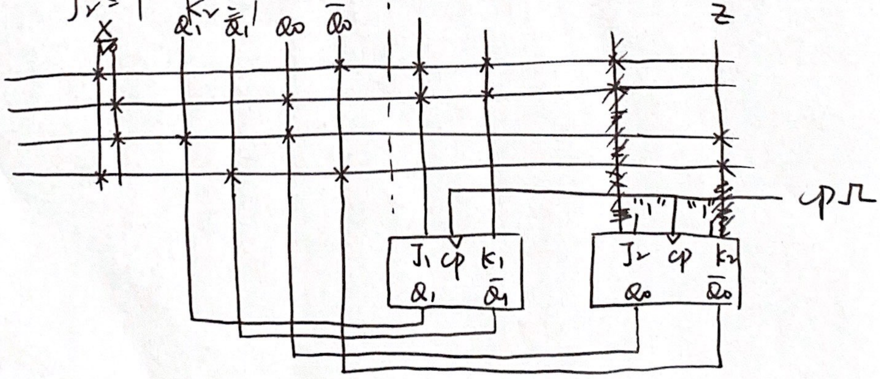


图 2: 7.9

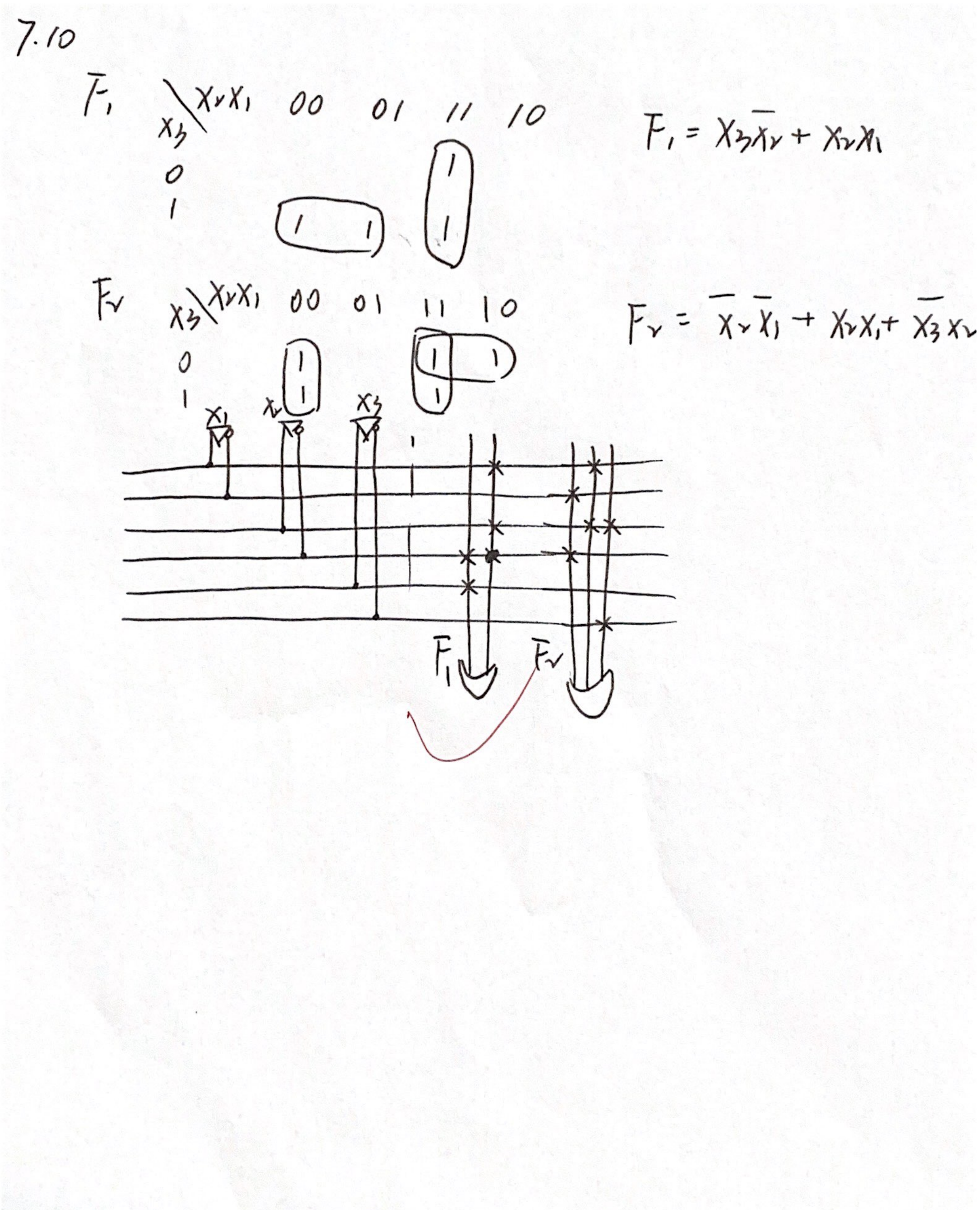

7.10
F_1
$x_3 \backslash x_2x_1$ 00 01 11 10
0
1
$F_1 = x_3\bar{x}_2 + x_2x_1$
F_2
$x_3 \backslash x_2x_1$ 00 01 11 10
0
1
$F_2 = \bar{x}_2\bar{x}_1 + x_2x_1 + \bar{x}_3x_2$
x_1
x_2
x_3
F_1
F_2

图 3: 7.10