CPU 设计: 8008

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目录

Chapter 1

微程序设计

1.1 子程序设计

- IF (Instruction Fetch): T1-T2-T3 (PCI)
- MR (Memory Read): T1-T2-T3 (PCR)
- MW (Memory Write): T1-T2-T3 (PCW)
- RR (Register Read): T4
- RW (Register Write): T5
- PCU (PC Update): T4-T5
- IOR (I/O Read): T3-T4-T5

1.2 指令组成

表 1.1: 指令组成

指令	指令码	组成
Lrr	11DDDSSS	PCO(PCL-PCH)-IF-rR-rW
LrM	11DDD111	PCO(PCL-PCH)-IF-MA(rLO-rMO)-MR-X1-rW
LMr	11111SSS	PCO(PCL-PCH)-IF-rR-MA(rLO-rMO)-MW
LrI	00DDD110	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-X1-rW
INr/DCr	00DDD00V	PCO(PCL-PCH)-IF-X1-rW
ALU OP r	10PPPSSS	PCO(PCL-PCH)-IF-rR-rW
ALU OP M	10PPP111	PCO(PCL-PCH)-IF-MA(rLO-rMO)-MR-X1-rW
ALU OP I	00PPP100	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-X1-rW
ROT	000VV010	PCO(PCL-PCH)-IF-X1-rW
JMP	01XXX100	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-PCO(PCL-PCH)-IMMa1-PCU(PCHU-PCLU)
JFc/JTc	01VCC000	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-PCO(PCL-PCH)-IMMa2-PCU(PCHU-PCLU)
CAL	01XXX110	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-PCO(PCL-PCH)-IMMa3-PCU(PCHU-PCLU)
CFc/CTc	01VCC010	PCO(PCL-PCH)-IF-PCO(PCL-PCH)-IMMb-PCO(PCL-PCH)-IMMa4-PCU(PCHU-PCLU)
RET	00XXX111	PCO(PCL-PCH)-IF-POP-X2
RFc/RTc	00VCC011	PCO(PCL-PCH)-IF-POPc(c)-X2
INP	0100MMM1	PCO(PCL-PCH)-IF-IO(rAO-rBO)-IOb-CO-rW
OUT	01RRMMM1	PCO(PCL-PCH)-IF-IO(rAO-rBO)-X0
HLT	0000000X	PCO(PCL-PCH)-IF
HLT	11111111	PCO(PCL-PCH)-IF

1.3 指令执行状态变化

1.4 微指令设计

1.4.1 微指令组成

- 状态码 (3 位)
- 寄存器组操作 (2 位): 输出使能, 写使能
-

1.4.2 指令分类

- $D_7D_6 = 00$: 特殊指令
  - $D_2D_1D_0 = 000$: HLT
  - $D_2D_1D_0 = 001$: HLT
  - $D_2D_1D_0 = 010$: ROT
  - $D_2D_1D_0 = 011$: RFc/RTc
  - $D_2D_1D_0 = 100$: ALU OP I
  - $D_2D_1D_0 = 101$: RST
  - $D_2D_1D_0 = 110$: LrM/LrI
  - $D_2D_1D_0 = 111$: RET
- $D_7D_6 = 01$: 跳转指令
  - $D_2D_1D_0 = 000$: JFc/JTc
  - $D_2D_1D_0 = 010$: CFc/CTc
  - $D_2D_1D_0 = 100$: JMP
  - $D_2D_1D_0 = 110$: CAL
  - $D_2D_1D_0 = XX1$: INP/OUT
- $D_7D_6 = 10$: 算术指令
- $D_7D_6 = 11$: 寄存器指令

1.4.3 微程序分类与跳转

使用 D_7D_6 进行一次分组, 使用 $D_2D_1D_0$ 进行二次分组

1.4.4 微指令转移

微指令转移按照如下计算规则:

$$A_i = \mu A_i + \sum P_i^I I_i + \sum P_i^S S_i + \sum P_i^C C_i \tag{1.1}$$

其中, μA_i 为微指令中的下一指令段, P 为微指令中的控制段, 按作用类型不同分为指令控制段 P_i^I, 状态控制段 P_i^S, 和条件控制段 P_i^C, I_i 为指令寄存器的位段, S_i 为状态寄存器的位段, C_i 为条件判定寄存器的位段.

1.4.5 微指令转移方式

- 直接转移: 微指令中的控制段均为 0, 微指令运行下一指令直接由微指令中的 μA_i 段决定.
- 按指令转移: 微指令中的指令控制段 P_i^I 不为 0, 此时, 微指令中的 μA_i 段决定跳转时的基址, $\sum P_i^I I_i$ 决定偏移量.
- 按状态转移: 微指令中的状态控制段 P_i^S 不为 0, 此时, 微指令中的 μA_i 段决定跳转时的基址, $\sum P_i^S S_i$ 决定偏移量.
- 按条件转移: 微指令中的条件控制段 P_i^C 不为 0, 此时, 微指令中的 μA_i 段决定跳转时的基址, $\sum P_i^C C_i$ 决定偏移量.
- 复合转移: 微指令中的 μA_i 段决定跳转时的基址, 结合指令控制段 P_i^I, 状态控制段 P_i^S, 和条件控制段 P_i^C 综合决定偏移量.

1.4.6 微指令转移方式

表 1.2: 微程序表

地址	微指令	状态	功能	下一微指令	下一状态	转移类型
0	PCL	T1	PCL 输出	PCH	T2	直接转移
1	PCH	T2	PCH 输出	IF, IMMa, IMMb	T3, WAIT	状态转移
2	IF	T3	DATA to IR and regB	rR, rLO, PCL, POP, POPc, rAO, X1	T4, T1, HLT	指令转移, 状态转移, 条件转移
	rR	T4	reg Read	rW, rLO	T5, T1, HLT	指令转移, 状态转移
	rW	T5	reg Write	PCL	T1, INT	指令转移, 状态转移
	rLO	T1	reg L Out	rHO	T2	直接转移
	rHO	T2	reg H Out	MR, MW	T3, WAIT	指令转移, 状态转移
	MR	T3	Memory Read	X1	T4	直接转移
	MW	T3	Memory Write	PCL	T1, INT	状态转移

1.4.7 跳转设计

1.4.7.1 IF 跳出

跳出指向

- rR: Lrr+LMr (11VVVSSS), ALU op r (10PPPSSS), 合并 (1XXXXSSS, SSS<>111)
- rLO: LrM (11DDD111, DDD<>111), ALU op M (10PPP111)
- rAO: INP+OUT (01XXXXX1)
- POP: RETURN (00XXXX11)
- PCL: JUMP, CALL (01XXXXX0)
- PCL(next): HLT, INT, NORMAL
- X1: INr/DCr

1.4.7.2 指令前缀 00

指令通过 $D_2D_1D_0$ 进行分类

- 000: HLT/INr (通过 $D_5D_4D_3$ 进行分类). IF-STOP/IF-X1
- 001: HLT/DCr (通过 $D_5D_4D_3$ 进行分类). IF-STOP/IF-X1
- 010: ROT (RLC, RRC, RAL, RAR, 通过 $D_5D_4D_3$ 进行分类). IF-X1
- 011: RFc/RTc. IF-POP
- 100: ALU op I. IF-PCL
- 101: RST. IF-PCLU2-PCHU2
- 110: LrI/LMI (通过 $D_5D_4D_3$ 进行分类). IF-PCL
- 111: RET. IF-POP

将微程序地址 10000-10111 与上面 8 个指令对应. 指令跳转表达式为

$$
\begin{aligned}
J_C &= \bar{D}_7\bar{D}_6(\overline{\bar{D}_2D_1D0} + \bar{D}_2D_1D_0J) && (1.2)\\
A_4 &= J_C1 && (1.3)\\
A_3 &= J_CP_0(D_7 + D_6) && (1.4)\\
A_2 &= J_C(\mu A_2 + P_0\bar{D}_7\bar{D}_6I_2) && (1.5)\\
A_1 &= J_C(\mu A_1 + P_0\bar{D}_7\bar{D}_6I_1) && (1.6)\\
A_0 &= J_C(\mu A_0 + P_0\bar{D}_7\bar{D}_6I_0) && (1.7)
\end{aligned}
$$

1.4.7.3 指令前缀 01

指令通过 $D_2D_1D_0$ 进行分类

- 000: JFc/JTc
- 010: CFc/CTc
- 100: JMP
- 110: CAL
- XX1: INP/OUT

将微程序地址 11000-11111 与上面 8 个指令对应. 指令跳转表达式为

$$
\begin{aligned}
J_C &= \bar{D}_7D_6(\overline{\bar{D}_2\bar{D}_0} + \bar{D}_2\bar{D}_0J) && (1.8)\\
A_4 &= \bar{J}_C1 && (1.9)\\
A_3 &= \bar{J}_C(P_0\bar{D}_7D_6) && (1.10)\\
A_2 &= \bar{J}_C(\mu A_2 + P_1\bar{D}_7D_6I_0) && (1.11)\\
A_1 &= \bar{J}_C(\mu A_2 + P_1\bar{D}_7D_6I_2) && (1.12)\\
A_0 &= \bar{J}_C(\mu A_2 + P_1\bar{D}_7D_6I_1\bar{I}_0 + P_1\bar{D}_7D_6\bar{I}_5\bar{I}_4I_0) && (1.13)
\end{aligned}
$$

1.4.7.4 指令前缀 10

指令通过 $D_2D_1D_0$ 进行分类

- SSS: ALU op r
- 111: ALU op M

将微程序地址 100000-100001 与上面 2 个指令对应. 指令跳转表达式为

$$
\begin{aligned}
A_5 &= D_7\bar{D}_6 && (1.14)\\
A_4 &= \overline{D_7\bar{D}_6} && (1.15)\\
A_3 &= \overline{D_7\bar{D}_6} && (1.16)\\
A_2 &= \overline{D_7\bar{D}_6} && (1.17)\\
A_1 &= \overline{D_7\bar{D}_6} && (1.18)\\
A_0 &= D_7\bar{D}_6I_2I_1I_0 && (1.19)
\end{aligned}
$$

1.4.7.5 指令前缀 11

指令通过 $D_5D_4D_3D_2D_1D_0$ 进行分类

- DDDSSS: Lrr
- DDD111: LrM
- 111SSS: LMr
- 111111: HLT

将微程序地址 100100-100111 与上面 4 个指令对应. 指令跳转表达式为

$$A_5 = D_7D_6 \tag{1.20}$$
$$A_4 = \overline{D_7D_6} \tag{1.21}$$
$$A_3 = \overline{D_7D_6} \tag{1.22}$$
$$A_2 = D_7D_6 \tag{1.23}$$
$$A_1 = D_7D_6I_5I_4I_3 \tag{1.24}$$
$$A_0 = D_7D_6I_2I_1I_0 \tag{1.25}$$

1.4.7.6 条件跳转

适用指令: JFc/JTc, CFc/CTc, RFc/RTc, 引入条件判定变量 J, 当条件成立时 $J = 1$, 否则 $J = 0$, 指令跳转表达式为

$$A_i = J() \tag{1.26}$$

1.4.8 微指令组合逻辑

- srcM: $D_2D_1D_0$
- dstM: $D_5D_4D_3$
- JUMP:

1.4.9 微指令表

表 1.3: 微指令表

地址	指令	微指令	S			P			μA				
			2	1	0	2	1	0	4	3	2	1	0
000000		PCL	0	1	0	0	0	0	0	0	0	0	1
000001		PCH	1	0	0	0	0	0	x	x	x	x	x
000010		IF	0	0	1	x	x	x	0	1	x	x	x
001000		rR	1	1	1	x	x	x	x	x	x	x	x
001001		POP	1	1	1	0	0	0	x	x	x	x	x
001010		X1	1	1	1	0	0	0	x	x	x	x	x
001100		rLO	0	1	0	0	0	0	x	x	x	x	x
001101		rAO	0	1	0	0	0	0	x	x	x	x	x
001110		PCL2	0	1	0	0	0	0	x	x	x	x	x
010000	INr		1	1	1				x	x	x	x	x
010001	DCr		1	1	1				x	x	x	x	x
010010	ROT		1	1	1				x	x	x	x	x
010011	RETc		1	1	1				x	x	x	x	x
010100	ALU op I		1	1	1				x	x	x	x	x
010101	RST		1	1	1				x	x	x	x	x
010110	LrI/LMI		1	1	1				x	x	x	x	x
010111	RET		1	1	1				x	x	x	x	x

表 1.3: 微指令表 (续)

地址	指令	微指令	S			P			μA				
			2	1	0	2	1	0	4	3	2	1	0
011000	JMPc		1	1	1				x	x	x	x	x
011001	CALc		1	1	1				x	x	x	x	x
011010	JMP		1	1	1				x	x	x	x	x
011011	CAL		1	1	1				x	x	x	x	x
011100	INP		1	1	1				x	x	x	x	x
011101	OUT		1	1	1				x	x	x	x	x
100000	ALU op r		1	1	1				x	x	x	x	x
100001	ALU op M		1	1	1				x	x	x	x	x
100100	Lrr		1	1	1				x	x	x	x	x
100101	LrM		1	1	1				x	x	x	x	x
100110	LMr		1	1	1				x	x	x	x	x
100111	HLT		1	1	1				x	x	x	x	x

1.5 微指令设计

1.5.1 指令译码

$$
\begin{aligned}
Lrr &= D_7D_6\overline{D_5D_4D_3}\ \overline{D_2D_1D_0} && (1.27)\\
LrM &= D_7D_6\overline{D_5D_4D_3}D_2D_1D_0 && (1.28)\\
LMr &= D_7D_6D_5D_4D_3\overline{D_2D_1D_0} && (1.29)\\
LrI &= \bar{D}_7\bar{D}_6\overline{D_5D_4D_3}D_2D_1\bar{D}_0 && (1.30)\\
LMI &= \bar{D}_7\bar{D}_6D_5D_4D_3D_2D_1\bar{D}_0 && (1.31)\\
INr &= \bar{D}_7\bar{D}_6\overline{D_5D_4D_3}\bar{D}_2\bar{D}_1\bar{D}_0 && (1.32)\\
DCr &= \bar{D}_7\bar{D}_6\overline{D_5D_4D_3}\bar{D}_2\bar{D}_1D_0 && (1.33)\\
ALUopR &= D_7\bar{D}_6\overline{D_2D_1D_0} && (1.34)\\
ALUopM &= D_7\bar{D}_6D_2D_1D_0 && (1.35)\\
ALUopI &= \bar{D}_7\bar{D}_6D_2\bar{D}_1\bar{D}_0 && (1.36)\\
ROT &= \bar{D}_7\bar{D}_6\bar{D}_2D_1\bar{D}_0 && (1.37)\\
JMP &= \bar{D}_7D_6D_2\bar{D}_1\bar{D}_0 && (1.38)\\
JMPc &= \bar{D}_7D_6\bar{D}_2\bar{D}_1\bar{D}_0 && (1.39)\\
CAL &= \bar{D}_7D_6D_2D_1\bar{D}_0 && (1.40)\\
CALc &= \bar{D}_7D_6\bar{D}_2D_1\bar{D}_0 && (1.41)\\
RET &= \bar{D}_7\bar{D}_6D_2D_1D_0 && (1.42)\\
RETc &= \bar{D}_7\bar{D}_6\bar{D}_2D_1D_0 && (1.43)\\
RST &= \bar{D}_7\bar{D}_6D_2\bar{D}_1D_0 && (1.44)\\
INP &= \bar{D}_7D_6\bar{D}_5\bar{D}_4D_0 && (1.45)\\
OUT &= \bar{D}_7D_6(\bar{D}_5+\bar{D}_4)D_0 && (1.46)\\
HLT &= \bar{D}_7\bar{D}_6\bar{D}_5\bar{D}_4\bar{D}_3\bar{D}_2\bar{D}_1 + D_7D_6D_5D_4D_3D_2D_1D_0 && (1.47)
\end{aligned}
$$

将指令分段

$$
\begin{aligned}
M_s &= D_2D_1D_0 && (1.48)\\
M_d &= D_5D_4D_3 && (1.49)
\end{aligned}
$$

指令编码公式如下

$$
\begin{aligned}
I_{Lrr} &= D_7D_6\overline{M_d}\ \overline{M_s} && (1.50)\\
I_{LrM} &= D_7D_6\overline{M_d}M_s && (1.51)\\
I_{LMr} &= D_7D_6M_d\overline{M_s} && (1.52)\\
I_{LrI} &= \bar{D}_7\bar{D}_6\overline{M_d}D_2D_1\bar{D}_0 && (1.53)\\
I_{LMI} &= \bar{D}_7\bar{D}_6M_dD_2D_1\bar{D}_0 && (1.54)\\
I_{INr} &= \bar{D}_7\bar{D}_6\overline{M_d}\bar{D}_2\bar{D}_1\bar{D}_0 && (1.55)\\
I_{DCr} &= \bar{D}_7\bar{D}_6\overline{M_d}\bar{D}_2\bar{D}_1D_0 && (1.56)\\
I_{ALUopR} &= D_7\bar{D}_6\overline{M_s} && (1.57)\\
I_{ALUopM} &= D_7\bar{D}_6M_s && (1.58)\\
I_{ALUopI} &= \bar{D}_7\bar{D}_6D_2\bar{D}_1\bar{D}_0 && (1.59)\\
I_{ROT} &= \bar{D}_7\bar{D}_6\bar{D}_2D_1\bar{D}_0 && (1.60)\\
I_{JMP} &= \bar{D}_7D_6D_2\bar{D}_1\bar{D}_0 && (1.61)\\
I_{JMPc} &= \bar{D}_7D_6\bar{D}_2\bar{D}_1\bar{D}_0 && (1.62)\\
I_{CAL} &= \bar{D}_7D_6D_2D_1\bar{D}_0 && (1.63)\\
I_{CALc} &= \bar{D}_7D_6\bar{D}_2D_1\bar{D}_0 && (1.64)\\
I_{RET} &= \bar{D}_7\bar{D}_6D_2D_1D_0 && (1.65)\\
I_{RETc} &= \bar{D}_7\bar{D}_6\bar{D}_2D_1D_0 && (1.66)\\
I_{RST} &= \bar{D}_7\bar{D}_6D_2\bar{D}_1D_0 && (1.67)\\
I_{INP} &= \bar{D}_7D_6\bar{D}_5\bar{D}_4D_0 && (1.68)\\
I_{OUT} &= \bar{D}_7D_6(D_5+D_4)D_0 && (1.69)\\
I_{HLT} &= \bar{D}_7\bar{D}_6\bar{D}_5\bar{D}_4\bar{D}_3\bar{D}_2\bar{D}_1+D_7D_6M_dM_s && (1.70)
\end{aligned}
$$

1.5.2 IF 转出设计

IF 转出到微地址 01000-01111, 转出编码

$$
\begin{aligned}
F_0 &= I_{HLT}\\
F_1 &= I_{Lrr}+I_{ALUopR}+I_{LMr}=D_7\bar{M}_s\\
F_2 &= I_{JMP}+I_{JMPc}+I_{CAL}+I_{CALc}+I_{LrI}+I_{LMI}+I_{ALUopI}=\bar{D}_7\bar{D}_0(D_6+\bar{D}_6D_2)\\
F_3 &= I_{LrM}+I_{ALUopM}=D_7M_s(D_6\bar{M}_d+\bar{D}_6)\\
F_4 &= I_{INP}+I_{OUT}=D_7\bar{D}_6D_0\\
F_5 &= I_{INr}+I_{DCr}+I_{ROT}=\bar{D}_7\bar{D}_6\bar{D}_2(\bar{M}_d\bar{D}_1+D_1\bar{D}_0)\\
F_6 &= I_{RET}+I_{RETc}=\bar{D}_7\bar{D}_6D_1D_0\\
F_7 &= I_{RST}=\bar{D}_7\bar{D}_6D_2\bar{D}_1D_0
\end{aligned}
$$

使用 8-3 编码器

$$\begin{aligned}
Y_0^0 &= F_1 + F_3 + F_5 + F_7 \\
Y_1^0 &= F_2 + F_3 + F_6 + F_7 \\
Y_2^0 &= F_4 + F_5 + F_6 + F_7
\end{aligned}$$

微地址转换公式如下

$$\begin{aligned}
A_4 &= \mu A_4 \\
A_3 &= \mu A_3 \\
A_2 &= P_0(Y_2^0) + \mu A_2 \\
A_1 &= P_0(Y_1^0) + \mu A_1 \\
A_0 &= P_0(Y_0^0) + \mu A_0
\end{aligned}$$

1.5.3 1 级转入设计

微地址编码

- 10000: rW
- 10001: ALU
- 10010: rL
- 10011: PCL
- 10100: IFb
- 10101: rB
- 10110: X3

Chapter 2

CPU 模块设计

2.1 模块组成

- Reg
- RegBank
- Stack

Chapter 3

微程序设计 2

3.1 指令跳转

$$
\begin{aligned}
A_5 &= \mu A_5 & (3.1)\\
A_4 &= \mu A_4 + P_4 \cdot D_7 & (3.2)\\
A_3 &= \mu A_3 + P_4 \cdot D_6 & (3.3)\\
A_2 &= \mu A_2 + P_0 \cdot D_2 & (3.4)\\
A_1 &= \mu A_1 + P_0 \cdot D_1 + P_3 \cdot D_5 D_4 D_3 & (3.5)\\
A_0 &= \mu A_0 + P_0 \cdot D_0 + P_1 \cdot D_0 + P_2 \cdot D_2 D_1 D_0 + P_3 \cdot D_2 D_1 D_0 & (3.6)\\
&+ P_5 \cdot D_5 D_4 D_3 + P_6 \cdot (D_5 + D_4) + P_7 \cdot D_4 & (3.7)
\end{aligned}
$$

简化表达式, 如下

$$
\begin{aligned}
A_5 &= \mu A_5 & (3.8)\\
A_4 &= \mu A_4 + P_6 \cdot D_7 & (3.9)\\
A_3 &= \mu A_3 + P_6 \cdot D_6 & (3.10)\\
A_2 &= \mu A_2 + P_0 \cdot D_2 & (3.11)\\
A_1 &= \mu A_1 + P_0 \cdot D_1 + P_5 \cdot D_5 D_4 D_3 & (3.12)\\
A_0 &= \mu A_0 + P_0 \cdot D_0 + P_1 \cdot D_2 D_1 D_0 + P_2 \cdot D_5 D_4 D_3 + P_3 \cdot (D_5 + D_4) + P_4 \cdot D_4 + P_7 \cdot D_1 & (3.13)
\end{aligned}
$$

进一步简化表达式, 如下

$$
\begin{aligned}
A_5 &= \mu A_5 & (3.14)\\
A_4 &= \mu A_4 + P_0 \cdot D_7 & (3.15)\\
A_3 &= \mu A_3 + P_0 \cdot D_6 & (3.16)\\
A_2 &= \mu A_2 + P_1 \cdot D_2 & (3.17)\\
A_1 &= \mu A_1 + P_1 \cdot D_1 + P_2 \cdot D_5 D_4 D_3 & (3.18)\\
A_0 &= \mu A_0 + P_1 \cdot D_0 + P_3 \cdot D_2 D_1 D_0 + P_3 \cdot D_5 + P_4 \cdot D_4 + P_5 \cdot D_1 & (3.19)
\end{aligned}
$$

3.1.1 分支设计

$$A_5 = \mu A_5 \tag{3.20}$$

$$A_4 = \mu A_4 + P_x \cdot D_7 \tag{3.21}$$

$$A_3 = \mu A_3 + P_x \cdot D_6 \tag{3.22}$$

$$A_2 = \mu A_2 + P_0 \cdot \bar{D_7}\bar{D_6}D_2 \tag{3.23}$$

$$A_1 = \mu A_1 + P_0 \cdot \bar{D_7}\bar{D_6}D_1 + P_3 \cdot D_7D_6D_5D_4D_3 \tag{3.24}$$

$$A_0 = \mu A_0 + P_0 \cdot \bar{D_7}\bar{D_6}D_0 + P_3 \cdot D_7D_6D_2D_1D_0 + P_4 \cdot (D_5 + D_4) + P_5 \cdot D_0 \tag{3.25}$$

$$\tag{3.26}$$

表 3.1: 微指令表

微地址	微指令	P						μA					
		5	4	3	2	1	0	4	3	2	1	0	
111101	IF_I	0	0	0	0	0	1	0	0	0	0	0	0
111110	PCH_I	0	0	0	0	0	0	1	1	1	1	0	1
111111	PCL_I	0	0	0	0	0	0	1	1	1	1	1	0

表 3.2: 微指令表

微地址	微指令	P					μA					
		4	3	2	1	0	4	3	2	1	0	
000000	X-INr											
000001	X-DCr											
000010	X-ALUop											
000011	POP(c)											
000100	PCL_Imm											
000101	PCHa											
000110	PCL_Imm											
000111	POP											
001000	PCL_ImmB											
001001	rA_o											
001010	ImmA											
001011	ImmA-PUSH											
010000	rR											
010001	rL_o											
010010	ALUop											
010011	rH_o											
010100	rB_i											
010101	X											
011000	rR											
011001	rR											
011010	rL_o											
011011	HLT											
100000	X	0	0	0	0	0	1	1	1	1	1	1
100001	rW	0	0	0	0	0	1	1	1	1	1	1
111101	IF	0	0	0	0	0	0	0	0	0	0	0
111110	PCH_I	0	0	0	0	0	1	1	1	1	0	1
111111	PCL_I	0	0	0	0	0	1	1	1	1	1	0

Chapter 4

基本逻辑

4.1 编码器

4.1.1 8-3 编码器

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	A_2	A_1	A_0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	1
0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	0
0	0	1	0	0	0	0	0	1	0	1
0	1	0	0	0	0	0	0	1	1	0
1	0	0	0	0	0	0	0	1	1	1

$$A_0 = D_1 + D_3 + D_5 + D_7 \tag{4.1}$$

$$A_1 = D_2 + D_3 + D_6 + D_7 \tag{4.2}$$

$$A_2 = D_4 + D_5 + D_6 + D_7 \tag{4.3}$$