Universitatea Politehnică Timișoara - Facultatea de Automatică și Calculatoare - Proiectarea microsistemelor digitale

Microsistem cu microprocesorul 8086

Hențiu Alexian-Tudor

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Tema proiectului

Să se proiecteze un microsistem cu următoarea structură:

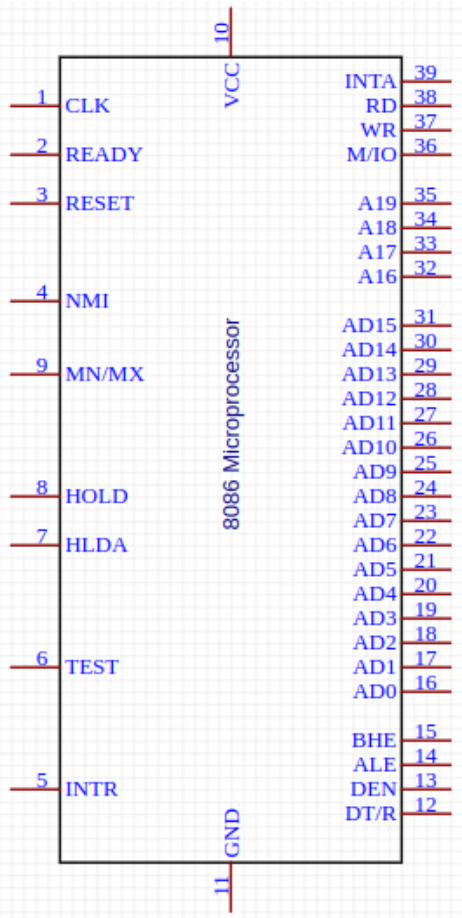
- ★ unitate centrală cu microprocesorul 8086;
- ★ 128 Ko memorie EPROM, utilizând circuite 27C512;
- ★ 64 Ko memorie SRAM, utilizând circuite 62256;
- ★ interfaţă serială, cu circuitul 8251, plasată în zona 0650H – 0652H sau 0E50H – 0E52H, în funcţie de poziţia microcomutatorului S1;
- ★ interfaţă paralelă, cu circuitul 8255, plasată în zona 0260H– 0266H sau 0360H – 0366H, în funcţie de poziţia microcomutatorului S2;
- ★ o minitastatură cu 9 contacte;
- ★ 24 LED-uri;
- ★ un modul de afişare cu 7 segmente, cu 6 ranguri (se pot afişa maxim 6 caractere hexa simultan);
- ★ Un modul LCD, cu 2 linii a câte 16 caractere fiecare, cu o interfață la alegerea studentului.

Programe:

- ➔ rutinele de programare ale circuitelor 8251 şi 8255;
- ➔ rutinele de emisie/ recepţie caracter pe interfaţa serială;
- ➔ rutina de emisie caracter pe interfaţă paralelă;
- ➔ rutina de scanare a minitastaturii;
- ➔ rutina de aprindere/ stingere a unui led;
- ➔ rutina de afișare a unui caracter hexa pe un rang cu segmente.

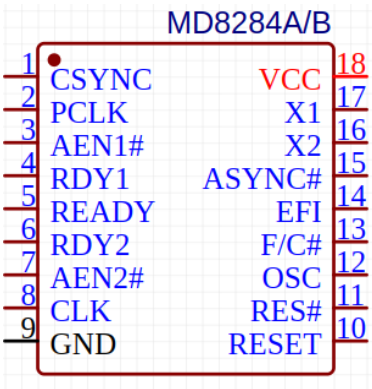
Hardware

Microprocesorul Intel 8086:



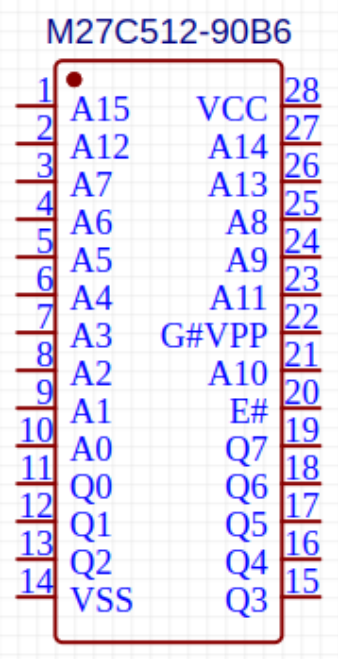
- AD0-AD15 - Magistrală multiplexată de adrese/date;
- A16-A19 - Rangurile 16-19 din magistrala de adrese;
- BHE - Bus High Enable;
- RESET - System Reset;
- CLK - System Clock;
- READY - Wait State Control;
- ALE - Address Latch Enable;
- WR - Write Control;
- RD - Read Control;
- M/IO - Memory / Input-Output Control;
- DT/R - Data Transfer / Receive;
- DEN - Data Enable;
- MN/MX - Mod de lucru procesor.

Generatorul de tact 8284:



- X1/X2 - Crystal In;
- CLK - Clock Output;
- PCLK - Peripheral Clock.

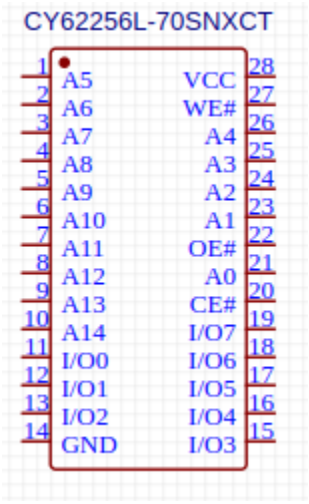
Memorie EPROM 27C512 (64 KO):



Mode	$\overline{E}$	$\overline{GV_{PP}}$	A9	Q7-Q0
Read	V_{IL}	V_{IL}	X	Data Out
Output Disable	V_{IL}	V_{IH}	X	Hi-Z
Program	V_{IL} Pulse	V_{PP}	X	Data In
Program Inhibit	V_{IH}	V_{PP}	X	Hi-Z
Standby	V_{IH}	X	X	Hi-Z
Electronic Signature	V_{IL}	V_{IL}	V_{ID}	Codes

Note: X = V_{IH} or V_{IL}, V_{ID} = 12V ± 0.5V.

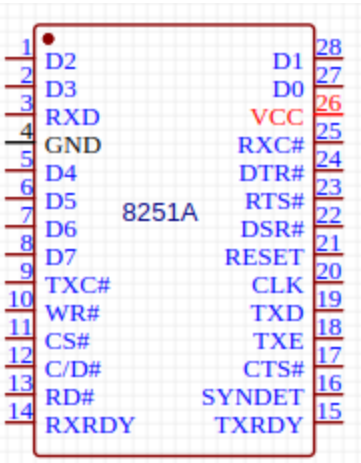
Memorie SRAM 62256 (32 KO):



$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	I/O Pin	Mode	Power
H	X	X	High-Z	Deselected	Standby
L	H	H	High-Z	Output Disabled	Active
L	L	H	Dout	Read	Active
L	X	L	Din	Write	Active

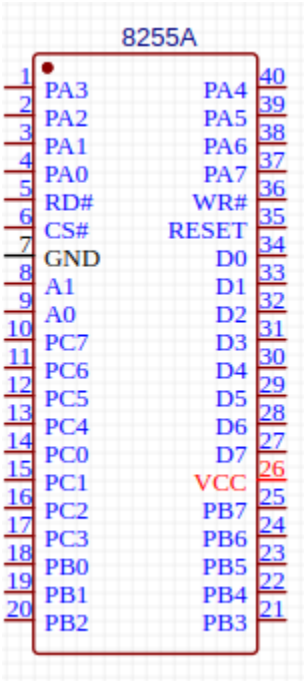
1. X means don't care

Circuitul 8251A (Serial):



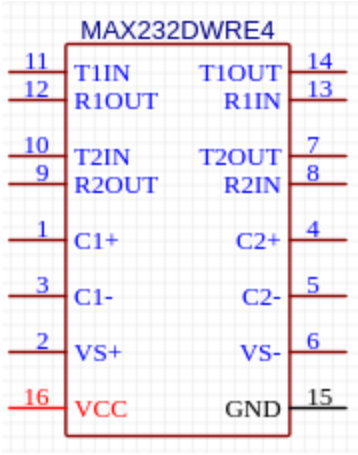
- D7-D0 - Parallel I/O;
- RXD - Receive serial data;
- TXD - Send serial data;
- CS, RD, WR, C/D - Control.

Circuitul 8255A (Paralel):

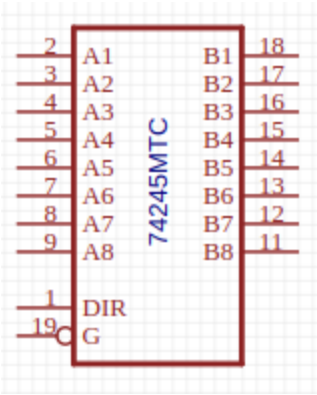


- PA0-PA7 (Port A), PB0-PB7 (Port B) - programmable I/O;
- PC0-PC7 (Port C) - I/O, pot furniza semnale de control;
- CS, RD, WR, C/D - control.

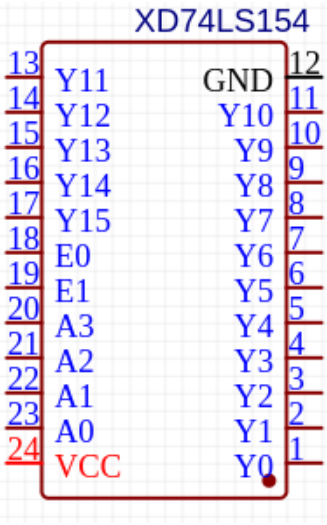
Circuitul MAX232:



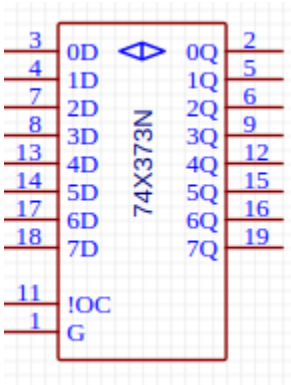
Circuitul 74x245 (amplificator / separator bidirecțional):



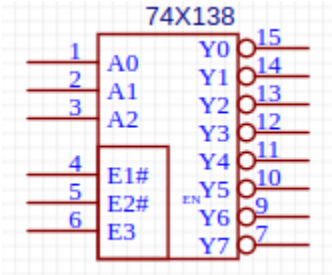
Circuitul 74LS154 (decodificator/demultiplexor):



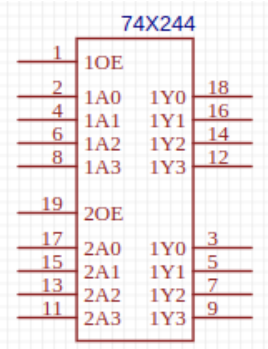
Circuitul 74x373 (registru):



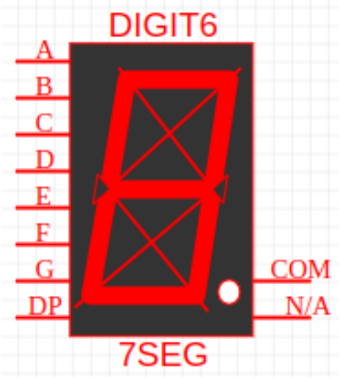
Circuitul 74x138 (decodificator):



Circuitul 74x244 (Octal Buffer / Driver):



Afișaj 7 segmente:



Caracter de reprezentat	Segmentul din afișaj							
	A (D0)	B (D1)	C (D2)	D (D3)	E (D4)	F (D5)	G (D6)	DP (D7)
0	0	0	0	0	0	0	1	1
1	1	0	0	1	1	1	1	1
2	0	0	1	0	0	1	0	1
3	0	0	0	0	1	1	0	1
4 (simplificat)	1	1	0	1	1	0	0	1
4	1	0	0	1	1	0	0	1
5	0	1	0	0	1	0	0	1
6	0	1	0	0	0	0	0	1
7	0	0	0	1	1	1	1	1
8	0	0	0	0	0	0	0	1
9	0	0	0	0	1	0	0	1
A	0	0	0	1	0	0	0	1
B	1	1	0	0	0	0	0	1
C	0	1	1	0	0	0	1	1
D	1	0	0	0	0	1	0	1
E	0	1	1	0	0	0	0	1
F	0	1	1	1	0	0	0	1

Decodificarea memoriei

Harta memoriilor:
SRAM1: 10000H - 107FFH
SRAM2: 10800H - 1FFFFH
EPROM1: E0000H - EFFFFH
EPROM2: F0000H - FFFFFH

BLOCK	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
SRAM1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SRAM2	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EPROM1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EPROM2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Ecuațiile de selecție:
SEL(SRAM) = ~A19 * ~A18 * ~A17 * A16
SEL(EPROM) = A19 * A18 * A17

Decodificarea interfețelor

Serială:

ADRESĂ	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0650H	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0
0652H	0	0	0	0	0	1	1	0	0	1	0	1	0	0	1	0
0E50H	0	0	0	0	1	1	1	0	0	1	0	1	0	0	0	0
0E52H	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	0

Paralelă:

ADRESĂ	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0260H	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
0266H	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0
0360H	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0
0366H	0	0	0	0	0	0	1	1	0	1	1	0	0	1	1	0

Decodificatorul de porturi

PORT	ADRESĂ	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
SL1	0000H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL2	0010H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
SL3	0020H	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
ST1	0030H	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
~ST2	0040H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SA1	0050H	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
SA2	0060H	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
SA3	0070H	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
SA4	0080H	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
SA5	0090H	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
SA6	00A0H	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

Assembly

Rutina de programare 8251:

- Pentru zona 0650H - 0652H:

```
MOV AL, 0CEH
OUT 0652H, AL
MOV AL, 15H
OUT 0652H, AL
RET
```

- Pentru zona 0E50H - 0E52H:

```
MOV AL, 0CEH
OUT 0E52H, AL
MOV AL, 15H
OUT 0E52H, AL
RET
```

Rutina de programare 8255:

- Pentru zona 0260H - 0266H:

```
MOV AL, 81H
OUT 0266H, AL
RET
```

- Pentru zona 0360H - 0366H:

```
MOV AL, 81H
OUT 0366H, AL
RET
```

Rutina de emisie caracter pe 8251:

- Pentru zona 0650H - 0652H:

```
SEND: IN AL, 0650H
      RCR AL, 1
      JNC SEND
      MOV AL, CL
      OUT 0650H, AL
      RET
```

- Pentru zona 0E50H - 0E52H:

```
SEND: IN AL, 0E50H
      RCR AL, 1
      JNC SEND
      MOV AL, CL
      OUT 0E50H, AL
      RET
```

Rutina de recepție caracter pe 8251:

- Pentru zona 0650H - 0652H:

```
READ: IN AL, 0650H
      RCR AL, 2
      JNC READ
      IN AL, 0650H
      MOV CL, AL
      RET
```

- Pentru zona 0E50H - 0E52H:

```
READ: IN AL, 0E50H
      RCR AL, 2
      JNC READ
      IN AL, 0E50H
      MOV CL, AL
      RET
```

Rutina de emisie caracter pe 8255:

- Pentru zona 0260H - 0266H:

```
L1: IN AL, 0260H
    RCR AL,1
    JNC L1
    MOV AL, CL
    OUT 0260H, AL
    OR AL, 01H
    OUT 0260H, AL ; ~STB = 1
    AND AL, 00H
    OUT 0260H, AL ; ~STB = 0
    OR AL, 01H
    OUT 0260H, AL ; ~STB = 1
    RET
```

- Pentru zona 0360H - 0366H:

```
L1: IN AL, 0360H
    RCR AL,1
    JNC L1
    MOV AL, CL
    OUT 0360H, AL
    OR AL, 01H
    OUT 0360H, AL ; ~STB = 1
    AND AL, 00H
    OUT 0360H, AL ; ~STB = 0
    OR AL, 01H
    OUT 0360H, AL ; ~STB = 1
    RET
```

Rutina de aprindere / stingere a unui LED:

- Aprindere:

```
    MOV AL, FFH
    MOV DX, 0010H
    OUT DX, AL
    RET
```

- Stingere:

```
    MOV AL, 00H
    MOV DX, 0010H
    OUT DX, AL
```

Rutina de afișare a unui caracter hexa pe un rang cu segment:

- DIGIT0:

```
; afișare ‘A’ pe display 1
MOV AL, 11H
OUT 0050H, AL
```

- DIGIT1:

```
; afișare ‘b’ pe display 2
MOV AL, C1H
OUT 0060H, AL
```

- DIGIT2:

```
; afișare ‘F’ pe display 3
MOV AL, 71H
OUT 0070H, AL
```

- DIGIT3:

```
; afișare ‘0’ pe display 4
MOV AL, 03H
OUT 0080H, AL
```

- DIGIT4:

```
; afișare ‘1’ pe display 5
MOV AL, 9FH
OUT 0090H, AL
```

- DIGIT5:

```
; afișare ‘4’ pe display 6
MOV AL, D9H
OUT 00A0H, AL
```

Rutina de scanare a minitastaturii:

```
        INT 25H
        ; CL - tasta citită
        ; se pune 0 pe col. 1 şi se verifică tastele 1,2,3
LOOP1:
        MOV AL, 0FEH
        MOV DX, 0030H
        OUT  DX, AL
        MOV DX, 0040H
        IN AL, DX ; citeste prima coloana
        AND AL, 02H ; verifica tasta 1
        JZ TASTA1
        AND AL, 04H ; verifica tasta 2
        JZ TASTA2
```

```
        AND AL, 08H ; verifica tasta 3
        JZ TASTA3

        ; se pune 0 pe col. 2 şi se verifică tastele 4,5,6
        MOV AL, 0FDH
        MOV DX, 0030H
        OUT  DX, AL
        MOV  DX, 0040H
        IN AL, DX
        AND AL, 02H ; verifica tasta 4
        JZ TASTA4
        AND AL, 04H ; verifica tasta 5
        JZ TASTA5
        AND AL, 08H ; verifica tasta 6
        JZ TASTA6

        ; se pune 0 pe col. 3 şi se verifică dacă s-au acţionat tastele 7,8,9
        MOV AL, 0FBH
        MOV DX, 0030H
        OUT  DX, AL
        MOV DX, 0040H
        IN AL, DX
        AND AL, 02H ; verifica  tasta 7
        JZ TASTA7
        AND AL, 04H ; verifica tasta 8
        JZ TASTA8
        AND AL, 08H ; verifica tasta 9
        JZ TASTA9

        JMP LOOP1

TASTA1:
        CALL DELAY ; se aşteaptă stabilizarea contactelor
AST1:
        IN AL, DX ; se citeste din nou linia şi se aşteaptă dezactivarea tastei
        AND AL, 02H
        JZ AST1
        CALL DELAY
        MOV CL, 01H
        RET

TASTA2:
        CALL DELAY
AST2:
```

```
        IN AL, DX
        AND AL, 02H
        JZ AST2
        CALL DELAY
        MOV CL, 02H
        RET

TASTA3:
        CALL DELAY
AST3:
        IN AL, DX
        AND AL, 02H
        JZ AST3
        CALL DELAY
        MOV CL, 03H
        RET

TASTA4:
        CALL DELAY
AST4:
        IN AL, DX
        AND AL, 04H
        JZ AST4
        CALL DELAY
        MOV CL, 04H
        RET

TASTA5:
        CALL DELAY
AST5:
        IN AL, DX
        AND AL, 04H
        JZ AST5
        CALL DELAY
        MOV CL, 05H
        RET

TASTA6:
        CALL DELAY
AST6:
        IN AL, DX
        AND AL, 04H
        JZ AST6
        CALL DELAY
```

```
        MOV CL, 06H
        RET

TASTA7:
        CALL DELAY
AST7:
        IN AL, DX
        AND AL, 04H
        JZ AST7
        CALL DELAY
        MOV CL, 07H
        RET

TASTA8:
        CALL DELAY
AST8:
        IN AL, DX
        AND AL, 08H
        JZ AST8
        CALL DELAY
        MOV CL, 08H
        RET

TASTA9:
        CALL DELAY
AST9:
        IN AL, DX
        AND AL, 08H
        JZ AST9
        CALL DELAY
        MOV CL, 09H
        RET
```

Bibliografie

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