

# Project Computerarchitectuur

EINDDOCUMENT

*Periode 4*

*predictably made with L<sup>A</sup>T<sub>E</sub>X*

SEMIH KARAKOÇ

Inholland Alkmaar

# Inhoudsopgave

|                                   |           |
|-----------------------------------|-----------|
| <b>1 Experiment 1</b>             | <b>2</b>  |
| 1.1 Deelexperiment 1              | 2         |
| 1.2 Deelexperiment 2              | 2         |
| 1.3 Deelexperiment 3              | 3         |
| 1.4 Deelexperiment 4              | 3         |
| <b>2 Experiment 2</b>             | <b>4</b>  |
| 2.1 Deelexperiment 1              | 4         |
| 2.2 Deelexperiment 2              | 4         |
| 2.3 Deelexperiment 3              | 4         |
| 2.4 Deelexperiment 4              | 5         |
| 2.5 Deelexperiment 5              | 6         |
| <b>3 Experiment 4</b>             | <b>6</b>  |
| 3.1 Deelexperiment 1              | 6         |
| 3.2 Deelexperiment 2              | 7         |
| 3.3 Deelexperiment 3              | 8         |
| 3.4 Deelexperiment 4              | 9         |
| <b>4 Experiment Traffic light</b> | <b>9</b>  |
| <b>5 Experiment 13</b>            | <b>10</b> |
| 5.1 Deelexperiment 1              | 10        |
| 5.2 Deelexperiment 2              | 11        |
| <b>6 Experiment 14</b>            | <b>11</b> |
| 6.1 Deelexperimenten 3 & 4        | 11        |
| 6.2 Deelexperiment 5              | 12        |
| 6.3 Deelexperiment 6              | 13        |
| <b>7 Experiment 8</b>             | <b>14</b> |
| 7.1 Deelexperiment 1              | 14        |
| 7.2 Deelexperiment 2              | 14        |
| 7.3 Deelexperiment 3              | 15        |
| <b>8 Experiment 15</b>            | <b>15</b> |
| 8.1 Deelexperiment 4              | 15        |
| 8.2 Deelexperiment 5              | 15        |
| 8.3 Deelexperiment 6              | 15        |
| 8.4 Deelexperiment 7              | 15        |

# 1 Experiment 1

## 1.1 Dealexperiment 1

|      |    |                |
|------|----|----------------|
| 1800 | 3E | LD A,n         |
| 1801 | 00 | n              |
| 1802 | 47 | LD B,A         |
| 1803 | 04 | INC B          |
| 1804 | 48 | LD C,B         |
| 1805 | 0C | INC C          |
| 1806 | 51 | LD D,C         |
| 1807 | 14 | INC D          |
| 1808 | 5A | LD E,D         |
| 1809 | 1C | INC E          |
| 180A | 63 | LD H,E         |
| 180B | 24 | INC H          |
| 180C | 6C | LD L,H         |
| 180D | 2C | INC L          |
| 180E | FF | RST 38H        |
| 180E |    | [SBR] Keypress |

## 1.2 Dealexperiment 2

|      |    |                 |
|------|----|-----------------|
| 1800 | 01 | opcode ld bc,nn |
| 1801 | 34 |                 |
| 1802 | 12 |                 |
| 1803 | 11 | opcode ld de,nn |
| 1804 | 78 |                 |
| 1805 | 56 |                 |
| 1806 | 21 | opcode ld hl,nn |
| 1807 | 0A |                 |
| 1808 | 09 |                 |

### 1.3 Deexperiment 3

|      |    |                   |
|------|----|-------------------|
| 1800 | 06 | opcode ld b,n     |
| 1801 | 20 | waarde 20 voor n  |
| 1802 | 21 | opcode hl,nn      |
| 1803 | 50 | waarde voor H     |
| 1804 | 18 | waarde voor L     |
| 1805 | AF | opcode XOR A      |
| 1806 | 77 | opcode ld (HL), a |
| 1807 | 23 | opcode inc HL     |
| 1808 | 05 | opcode dec B      |
| 1809 | 20 | opcode jr nz,d    |
| 180A | FA | -6 voor de loop   |
| 180B | FF | rst               |

### 1.4 Deexperiment 4

|      |    |           |
|------|----|-----------|
| 1800 | 06 | ld b,n    |
| 1801 | 10 | 10 cycles |
| 1802 | 21 | ld hl,nn  |
| 1803 | 40 |           |
| 1804 | 18 |           |
| 1805 | 3E | ld a,n    |
| 1806 | 00 |           |
| 1807 | 77 | ld (HL),a |
| 1808 | 3C | inc a     |
| 1809 | 23 | inc HL    |
| 180A | 05 | dec b     |
| 180B | C2 |           |
| 180C | 07 |           |
| 180D | 18 |           |

## 2 Experiment 2

### 2.1 Dealexperiment 1

|      |    |              |
|------|----|--------------|
| 1800 | 7B | ld a,e       |
| 1801 | 82 | add a,d      |
| 1802 | 6F | ld l,a       |
| 1803 | 3E | ld a,n       |
| 1804 | 00 | value n = 00 |
| 1805 | CE | adc a,n      |
| 1806 | 00 | value n = 00 |
| 1807 | 67 | ld h,a       |
| 1808 | FF | exit         |

RESULT: 5AA6: HL=0100, S=0, Z=0, P/V=0, C=1 4677: HL=00BD, S=0, Z=0, P/V=0, C=0

### 2.2 Dealexperiment 2

|      |    |           |
|------|----|-----------|
| 1800 | 3A | LD A,(NN) |
| 1801 | 00 |           |
| 1802 | 1A |           |
| 1803 | 83 | ADD A,E   |
| 1804 | 6F | L,A       |
| 1805 | 3A | LD A,(NN) |
| 1806 | 01 |           |
| 1807 | 1A |           |
| 1808 | 8A | ADC A,D   |
| 1809 | 67 | LD H,A    |
| 180A | FF | EXIT      |

RESULT:

DE = 4677 HL = 4C7C (A) FLAG = 08

H=0 P/V=1 CARRY = 0 ZERO = 1 OVERFLOW = 0 SIGN = 0

### 2.3 Dealexperiment 3

|      |    |           |
|------|----|-----------|
| 1800 | 3A | LD A,(NN) |
| 1801 | 00 |           |
| 1802 | 1A |           |
| 1803 | 93 | SUB A,E   |
| 1804 | 6F | L,A       |
| 1805 | 3A | LD A,(NN) |
| 1806 | 01 |           |
| 1807 | 1A |           |
| 1808 | 9A | SBC A,D   |
| 1809 | 67 | LD H,A    |
| 180A | FF | EXIT      |

RESULT:

DE=4677 HL=BF8E A=BF  
SIGN=1 H=1 CARRY=1 P/V=1

## 2.4 Deexperiment 4

|      |    |                   |
|------|----|-------------------|
| 1800 | 06 | LD B,n            |
| 1801 | 04 | n                 |
| 1802 | DD | LD IX, nn         |
| 1803 | 21 |                   |
| 1804 | 00 | nn                |
| 1805 | 1A |                   |
| 1806 | A7 | AND A             |
| 1807 | DD | LD A,(IX+d)       |
| 1808 | 7E |                   |
| 1809 | 00 | d                 |
| 180A | DD | ADC A,(IX+d)      |
| 180B | 8E |                   |
| 180C | 04 | d                 |
| 180D | DD | LD (IX+d), A      |
| 180E | 77 |                   |
| 180F | 08 | d                 |
| 1810 | DD | INC IX            |
| 1811 | 23 |                   |
| 1812 | 05 | DEC B             |
| 1813 | C2 | JP NZ, memaddress |
| 1814 | 07 | mem               |
| 1815 | 18 | address           |
| 1816 | FF | RST 38H           |

Results:

1A03 t/m 1A00: 14,13,12,11

1A07 t/m 1A04: 18,17,16,15

Resultaat: 1A0B t/m 1A08: 2C,2A,28,26

Flag Register: 2C t/m S=0 Z=0 H=0 P/V=1 N=0 C=0

## 2.5 Dealexperiment 5

|      |    |                   |
|------|----|-------------------|
| 1800 | 06 | LD B,n            |
| 1801 | 04 | n                 |
| 1802 | DD | LD IX, nn         |
| 1803 | 21 |                   |
| 1804 | 00 | nn                |
| 1805 | 1A |                   |
| 1806 | A7 | AND A             |
| 1807 | DD | LD A,(IX+d)       |
| 1808 | 7E |                   |
| 1809 | 00 | d                 |
| 180A | DD | SBC A,(IX+d)      |
| 180B | 9E |                   |
| 180C | 04 | d                 |
| 180D | 27 | DAA               |
| 180E | DD | LD (IX+d), A      |
| 180F | 77 |                   |
| 1810 | 08 | d                 |
| 1811 | DD | INC IX            |
| 1812 | 23 |                   |
| 1813 | 05 | DEC B             |
| 1814 | C2 | JP NZ, memaddress |
| 1815 | 07 | mem               |
| 1816 | 18 | address           |
| 1817 | FF | RST 38H           |

## 3 Experiment 4

### 3.1 Dealexperiment 1

|      |    |              |
|------|----|--------------|
| 1800 | 21 | LD HL, (nn)  |
| 1801 | 00 |              |
| 1802 | 19 |              |
| 1803 | 06 | LD B, n      |
| 1804 | 20 |              |
| 1805 | 77 | LD (HL), A   |
| 1806 | 23 | INC HL       |
| 1807 | 10 | DJNZ, e      |
| 1808 | FC | DECIMAL = -5 |
| 1809 | FF | RST 38H      |

0

Results:

- 1) 1900 t/m 191F → 0  
1920 → Niet veranderd
- 2) 1900 t/m 191F → 55
- 3) 1900 t/m 19FF → 64

### 3.2 Dealexperiment 2

Normal:

|      |    |              |
|------|----|--------------|
| 1800 | 21 | LD HL, (nn)  |
| 1801 | FF |              |
| 1802 | 19 |              |
| 1803 | 0E | LD C, n      |
| 1804 | 0F |              |
| 1805 | 06 | LD B, n      |
| 1806 | 10 |              |
| 1807 | 71 | LD (HL), C   |
| 1808 | 2B | DEC HL       |
| 1809 | 10 | DJNZ         |
| 180A | FC | DECIMAL = -5 |
| 180B | 0D | DEC C        |
| 180C | C2 | JP NZ, nnc   |
| 180D | 05 |              |
| 180E | 18 |              |
| 180F | FF | RST 38H      |

Inverse:

|      |    |              |
|------|----|--------------|
| 1800 | 21 | LD HL, (nn)  |
| 1801 | 00 |              |
| 1802 | 19 |              |
| 1803 | 0E | LD C, n      |
| 1804 | 00 |              |
| 1805 | 06 | LD B, n      |
| 1806 | 10 |              |
| 1807 | 71 | LD (HL), C   |
| 1808 | 23 | INC HL       |
| 1809 | 10 | DJNZ, e      |
| 180A | FC | DECIMAL = -5 |
| 180B | 0C | INC C        |
| 180C | C2 | JP NZ, nn    |
| 180D | 05 |              |
| 180E | 18 |              |
| 180F | FF | RST 38H      |



|          | Normal:       |   | Inverse:      |    |
|----------|---------------|---|---------------|----|
|          | 1900 t/m 190F | 0 | 1900 t/m 190F | FF |
|          | 1910 t/m 191F | 1 | 1910 t/m 191F | FE |
|          | 1920 t/m 192F | 2 | 1920 t/m 192F | FD |
|          | 1930 t/m 193F | 3 | 1930 t/m 193F | FC |
|          | 1940 t/m 194F | 4 | 1940 t/m 194F | FB |
|          | 1950 t/m 195F | 5 | 1950 t/m 195F | FA |
|          | 1960 t/m 196F | 6 | 1960 t/m 196F | F9 |
| Results: | 1970 t/m 197F | 7 | 1970 t/m 197F | F8 |
|          | 1980 t/m 198F | 8 | 1980 t/m 198F | F7 |
|          | 1990 t/m 199F | 9 | 1990 t/m 199F | F6 |
|          | 19A0 t/m 19AF | A | 19A0 t/m 19AF | F5 |
|          | 19B0 t/m 19BF | B | 19B0 t/m 19BF | F4 |
|          | 19C0 t/m 19CF | C | 19C0 t/m 19CF | F3 |
|          | 19D0 t/m 19DF | D | 19D0 t/m 19DF | F2 |
|          | 19E0 t/m 19EF | E | 19E0 t/m 19EF | F1 |
|          | 19F0 t/m 19FF | F | 19F0 t/m 19FF | F0 |

### 3.3 Deexperiment 3

|      |    |            |
|------|----|------------|
| 1800 | 01 | LD BC, nn  |
| 1801 | 80 |            |
| 1802 | 01 |            |
| 1803 | 21 | LD HL, nn  |
| 1804 | 80 |            |
| 1805 | 18 |            |
| 1806 | 36 | LD (HL), n |
| 1807 | AA |            |
| 1808 | 23 | INC HL     |
| 1809 | 0B | DEC BC     |
| 180A | 78 | LD A, B    |
| 180B | B1 | OR C       |
| 180C | 20 | JR NZ, e   |
| 180D | F8 |            |
| 180E | 76 | HALT       |

### 3.4 Deexperiment 4

|    |      |    |            |
|----|------|----|------------|
|    | 1800 | 21 | LD HL, nn  |
|    | 1801 | 00 |            |
|    | 1802 | 1B |            |
|    | 1803 | 11 | LD DE, nn  |
|    | 1804 | 00 |            |
|    | 1805 | 1A |            |
|    | 1806 | 7E | LD A, (HL) |
|    | 1807 | 12 | LD (DE), A |
| 1. | 1808 | FE | CP, n      |
|    | 1809 | FF |            |
|    | 180A | 28 | JR Z, n    |
|    | 180B | 04 |            |
|    | 180C | 23 | INC HL     |
|    | 180D | 13 | INC DE     |
|    | 180E | 18 | JR, n      |
|    | 180F | F6 |            |
|    | 1810 | FF | RST 38H    |

|    |      |    |            |
|----|------|----|------------|
|    | 1800 | 7E | LD A, (HL) |
|    | 1801 | ED | NEG        |
|    | 1802 | 44 |            |
|    | 1803 | 77 | LD (HL), A |
|    | 1804 | 23 | INC HL     |
|    | 1805 | A7 | AND A      |
| 2. | 1806 | ED | SBC HL, DE |
|    | 1807 | 52 |            |
|    | 1808 | 19 | ADD HL, DE |
|    | 1809 | 20 | JR NZ, n   |
|    | 180A | F5 |            |
|    | 180B | FF | RST 38H    |

## 4 Experiment Traffic light

[Youtube link](#)

## 5 Experiment 13

### 5.1 Deexperiment 1

|      |             |  |
|------|-------------|--|
| 1800 | DD 21 00 19 |  |
| 1804 | 11 00 00    |  |
| 1807 | CD 24 06    |  |
| 180A | CD 18 2D    |  |
| 180D | 30F8        |  |
| 180F | 7B          |  |
| 1810 | C6 01       |  |
| 1812 | 27          |  |
| 1813 | 5F          |  |
| 1814 | 7A          |  |
| 1815 | CE 00       |  |
| 1817 | 27          |  |
| 1818 | 57          |  |
| 1819 | 7B          |  |
| 181A | 21 00 19    |  |
| 181D | CD 78 06    |  |
| 1820 | 36 02       |  |
| 1822 | 23          |  |
| 1823 | 7A          |  |
| 1824 | CD          |  |
| 1825 | 78          |  |
| 1826 | 06          |  |
| 1827 | 36          |  |
| 1828 | 00          |  |
| 1829 | 18          |  |
| 182A | DC          |  |
| 182B | 00          |  |
| 182C | 00          |  |
| 182D | 01          |  |
| 182E | D8          |  |
| 182F | 0E          |  |
| 1830 | ED          |  |
| 1831 | A1          |  |
| 1832 | 00          |  |
| 1833 | 00          |  |
| 1834 | E0          |  |
| 1835 | 18          |  |
| 1836 | F9          |  |

## 5.2 Dealexperiment 2

|      |             |                              |
|------|-------------|------------------------------|
| 1800 | DD 21 00 19 |                              |
| 1804 | 11 00 00    |                              |
| 1807 | 0E BD       | LD C, BD                     |
| 1809 | 21 00 19    | LD HL,nn TARGET ADDRESS 1900 |
| 180C | 06 05       | LOOP 5 TIMES                 |
| 180E | 71          | LD (HL), C - LOOP            |
| 180F | 23          | INC HL                       |
| 1810 | 10 FC       | GOTO LOOP                    |
| 1812 | CD 24 06    |                              |
| 1815 | 30 FB       |                              |
| 1817 | 7B          |                              |
| 1818 | C6 01       |                              |
| 181A | 27          |                              |
| 181B | 5F          |                              |
| 181C | 7A          |                              |
| 181D | CE          |                              |
| 181E | 00          |                              |
| 181F | 27          |                              |
| 1820 | 57          |                              |
| 1821 | 7B          |                              |
| 1822 | 21          |                              |
| 1823 | 00          |                              |
| 1824 | 19          |                              |
| 1825 | CD          |                              |
| 1826 | 78          |                              |
| 1827 | 06          |                              |
| 1828 | 36          |                              |
| 1829 | 02          |                              |
| 182A | 23          |                              |
| 182B | 7A          |                              |
| 182C | CD          |                              |
| 182D | 78          |                              |
| 182E | 06          |                              |
| 182F | 36          |                              |
| 1830 | 00          |                              |
| 1831 | 18          |                              |
| 1832 | DF          |                              |

## 6 Experiment 14

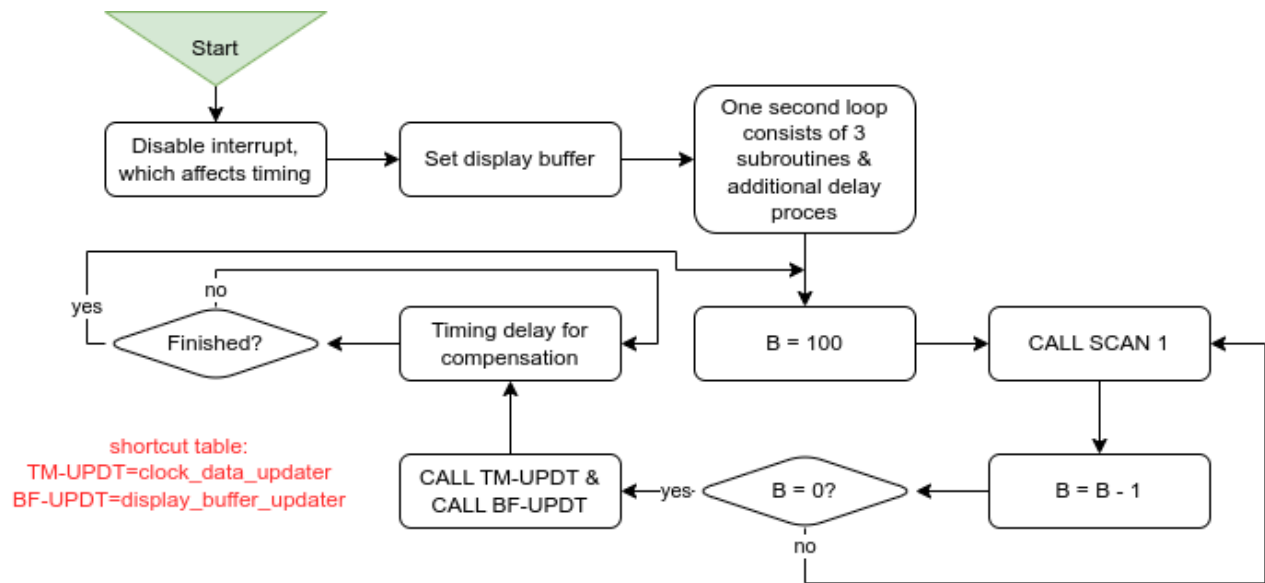
### 6.1 Dealexperimenten 3 & 4

- 3) Clock loads with time except clock is limited to max 11 hrs
- 4) Seconds are now limited to 24 seconds and after this is reached the minutes go plus 1

## 6.2 Dealexperiment 5

|      |          |    |  |
|------|----------|----|--|
| 1800 | F3       | 2  | DI ;Disable interrupt, which affects timing          |
| 1801 | DD21031A | 3  | LD IX,OUTBF  |
| 1805 | 0664     | 9  | LD B, 100 7  |
| 1807 | CD2406   | 10 | LOOP1 CALL SCAN1                                     |
| 180A | 10FB     | 11 | DJNZ LOOP1 ; (17+17812+13)*100 5=1784195             |
| 180C | CD1718   | 12 | CALL TMUPDT ;17+258=275                              |
| 180F | CD2F18   | 13 | CALL BFUPDT ;17+914=931                              |
| 1812 | 00       | 14 | LOOP2 NOP  |
| 1813 | 10FD     | 15 | DJNZ LOOP2 ; (4+13)*256-5=4347                       |
| 1815 | 18EE     | 16 | JR ONESEC 12   |
| 1817 | 214718   | 23 | LD HL, MAXTAB  |
| 181A | 11001A   | 24 | LD DE, SEC   |
| 181D | 0603     | 25 | LD B, 3  |
| 181F | 37       | 26 | SCF ;Set carry flag: force add 1                     |
| 1820 | 1A       | 27 | TMINC LD A, (DE)                                     |
| 1821 | CE00     | 28 | ADC A,O  |
| 1823 | 27       | 29 | DAA  |
| 1824 | 12       | 30 | LD (DE), A   |
| 1825 | 96       | 31 | SUB (HL) ;Compare wth data in MAX TAB                |
| 1826 | 3801     | 36 | JR C,COMPL   |
| 1828 | 12       | 37 | LD (DE),A  |
| 1829 | 3F       | 38 | COMPL CCF ;complement carry flag                     |
| 182A | 23       | 39 | INC HL   |
| 182B | 13       | 40 | INC DE   |
| 182C | 10F2     | 41 | DJNZ TM INC  |
| 182E | C9       | 42 | RET  |
|      |          | 44 | ;Displaybuffer is updated here. It takes 914 cycles. |
| 182F | 21031A   | 48 | LD HL, OUTBF   |
| 1832 | 11001A   | 49 | LD DE, SEC   |
| 1835 | 0603     | 50 | LD B,3   |
| 1837 | 1A       | 51 | PUTBF LD A, (DE)                                     |
| 1838 | CD6D06   | 52 | CALL HEX7SG  |
| 183B | 13       | 53 | INC DE   |
| 183C | 10F9     | 54 | DJNZ PUTBF   |
| 183E | 2B       | 55 | DEC HL   |
| 183F | 2B       | 56 | DEC HL   |
| 1840 | CBF6     | 57 | SET 6, (HL) ;Set decimal point of HOUR               |
| 1842 | 2B       | 58 | DEC HL   |
| 1843 | 2B       | 59 | DEC HL   |
| 1844 | CBF6     | 60 | DEC HL ;Set decimal point of MTNUTE                  |
| 1846 | C9       | 61 | RET ;B=0 when, return                                |
| 1847 |          | 60 | 64 DEFB 20H  |
| 1848 |          | 60 | 65 DEFB 20H  |
| 1849 |          | 12 | 66 DEFB 1H   |

### 6.3 Deexperiment 6



Het verschil tussen deze flowchart en die van het MPF-1B boek is dat deze iets andere symbolen gebruikt en afgekorte termen gebruikt. Daarnaast als je dit zou aanpassen dat het ook werkt met Exp 14-5, zullen er bepaalde waarden in het programma en flowchart ook veranderen.

## 7 Experiment 8

### 7.1 Dealexperiment 1

### 7.2 Dealexperiment 2

|   | <b>Binary</b>   |
|---|---|
| 1 | 1000000000  |
| 2 | 1111111111111111  |
| 3 | 00011000000000000000  |
| 4 | 01011010010010000011010001111111  |
| 5 | 0100001010010100100101100111001010010110  |
| 6 | 1001001000100011001101110010000000110110100001010100011101110110000000000000                        |
| 7 | 00011000010001000110011101000100000001110011011100001001010101010001011000010101                    |
|   | <b>Hexadecimal</b>  |
| 1 | 0200  |
| 2 | FFFF  |
| 3 | 18000   |
| 4 | 5A48347F  |
| 5 | 4294967296  |
| 6 | $9.223372^{18}$   |
| 7 | $1.8446744^{19}$  |
|   | <b>Decimal</b>  |
| 1 | 512   |
| 2 | 65535   |
| 3 | 98304   |
| 4 | 1514681471  |
| 5 | 285960729238  |
| 6 | 43132194673522839609344   |
| 7 | 114598615266301018707477  |
|   | <b>BCD</b>  |
| 1 | 0101 0001 0010  |
| 2 | 0110 0101 0101 0011 0101  |
| 3 | 1001 1000 0011 0000 0100  |
| 4 | 0001 0101 0001 0100 0110 1000 0001 0100 0111 0001   |
| 5 | 0010 1000 0101 1001 0110 0000 0111 0010 1001 0010 0011 1000   |
| 6 | 0100 0011 0001 0011 0010 0001 1001 0100 0110 0111 0011 0101 0010 0010 1000 0011 1001 0110 0000 1001 |
| 7 | 0001 0001 0100 0101 1001 1000 0110 0001 0101 0010 0110 0110 0011 0000 0001 0000 0001 1000 0111 0000 |
|   | <b>Registers D &amp; E</b>  |
| 1 | 2,2   |
| 2 | 2,3   |
| 3 | 3,4   |
| 4 | 4,6   |
| 5 | 8,A   |
| 6 | 8,A   |
| 7 | 8,A   |

### 7.3 Deexperiment 3

|      |    |          |
|------|----|----------|
| 1800 | 7B | LD a, e  |
| 1801 | 47 | LD b, a  |
| 1802 | 87 | ADD a, a |
| 1803 | 87 | ADD a, a |
| 1804 | 87 | ADD a, a |
| 1805 | 90 | SUB b    |

## 8 Experiment 15

1,2,3,8 kunnen ook niet omdat het geen opdrachten zijn.

### 8.1 Deexperiment 4

kan niet, omdat we geen tape/audio recorder hebben.

### 8.2 Deexperiment 5

De klok is  $\pm 2x$  zo snel de secondes aan het tellen.

### 8.3 Deexperiment 6

Op adressen 1807, 180B, 180F data van 40  $\rightarrow$  42 aanpassen (van CTC0 naar CTC2).

### 8.4 Deexperiment 7

Hij heeft een andere maximum telling van seconden, minuten en uren.