**ΑΣΚΗΣΗ 3**

Accumulator: 1011

Pc: 1101

X: 1001

zi: 6 6 2 5 6 1 4 0

yi: 7 6 6 6 4 0 7 4

**LDA K(Χ)**

**PC + 1 -> PC, MAR** // Το Κ στο MDR

**MDR + X -> NOP, MAR** // Το (Κ+$Χ) στον MAR, άρα το περιεχόμενο του αθροίσματος στον MDR

**MDR + 0 -> ACC** // Το περιεχόμενο του αθροίσματος στον ACC

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**LDX #K** // φόρτωσε στον βοηθητικό καταχώρηση Χ τον διψήφιο δεκαεξαδικό αριθμό Κ

**PC + 1 -> PC, MAR** // Το Κ στο MDR

**MDR + 0 -> X** // Το Κ στον Χ

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**INX** // Αύξηση κατά 1 του περιεχομένου του καταχωρητή Χ

**X + 1 -> X** // αύξηση του Χ

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**CMPX #Κ**

**PC + 1 -> PC, MAR**

**X – MDR -> NOP, MSTATUSCLK**

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**STA Κ(Χ)**

**PC + 1 -> PC, MAR** //Το Κ στο MDR

**MDR + X -> NOP, MAR**

**ACC + 0 -> NOP, MWE~**

**PC + 1 -> PC, MAR**

**ADC K(X)**

**PC + 1 -> PC, MAR** //Το Κ στο MDR

**MDR + X -> MAR**

**ACC + MDR -> ACC, MSTATUSCLK**

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**CRC**

**0 + 0 -> NOP, MSTATUSCLK** // Καθαρισμός της σημαίας κρατουμένου

**PC + 1 -> PC, MAR**

**NEXT(PC)**

**JNZ $K**

**SHLA**

**ACC + 0 -> SHIFTLEFT, ACC**

**PC + 1 -> PC, MAR**

**NEXT (PC)**

**HALT**

**PC + 0 -> PC, MAR**

**NEXT (PC)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **LDA K(Χ)** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| MDR+X -> NOP,MAR | XXXXX | 000 | XXX | 101 | 000 | 001 | 1001 | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |  |
| MDR+0->ACC | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 1001 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |  |
| PC+1->PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **LDX #K** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1-> PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| MDR+0->X | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 1001 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **INX** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| X+1->X | XXXXX | 000 | XXX | 101 | 000 | 011 | 1001 | 1001 | 01 | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **CMPX #Κ** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| X-MDR->NOP, MSTATUSCLK | XXXXX | 000 | XXX | 101 | 001 | 001 | 1001 | XXXX | XX | X | X | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **STA Κ(Χ)** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| MDR + X -> NOP, MAR | XXXXX | 000 | XXX | 101 | 000 | 001 | 1001 | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |  |
| ACC + 0 -> NOP, MWE~ | XXXXX | 000 | XXX | 101 | 000 | 011 | 1011 | XXXX | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **ADC K(X)** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| MDR + X -> MAR |  |  |  |  |  |  | 1001 | XXXX |  |  |  |  |  |  |  |  |  |  |  |  |
| ACC + MDR -> ACC, MSTATUSCLK |  |  |  |  |  |  | 1011 | 1011 |  |  |  |  |  |  |  |  |  |  |  |  |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **CRC** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | ADDRESS |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| 0+0->CARRYE | XXXXX | 000 | XXX | 111 | 000 | 001 | XXXX | XXXX | 00 | X | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **JNZ $K** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
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| **SHLA** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| ACC + 0 -> SHIFTLEFT, ACC |  |  |  |  |  |  | 1011 | 1011 |  |  |  |  |  |  |  |  |  |  |  |  |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1101 | 1101 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT (PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **HALT** | BRA | BIN | CON | I | I | I | APORT | BPORT | DDATA | SH~ | SELB | MWE~ | MARCLK | MSTATUS | LDS~ | PCE~ | CARRYE~ | MDE~ | DDATAE~ | **ADDRESS** |
|  | (4:0) | (2:0) | (2:0) | (2:0) | (5:3) | (8:6) | (3:0) | (3:0) | (1:0) |  |  |  |  |  |  |  |  |  |  |  |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1011 | 1011 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |  |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X |  |

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| **MAIN** | | |
| m00 | **00** | //opcode LDA |
| m01 | **08** | //έντελο LDA |
| m02 | **06** | //opcode STA |
| m03 | **0e** | //έντελο STA |
| m04 | **01** | //opcode LDX |
| m05 | **09** | //έντελο LDX |
| m06 | **07** | //opcode STX |
| m07 | **0f** | //έντελο STX |
| m08 | **02** | //opcode LDA ($K) |
| m09 | **0a** | //έντελο LDA ($K) |
| m0a | **06** | //opcode STA |
| m0b | **10** | //έντελο STA |
| m0c | **03** | //opcode LDAX |
| m0d | **0b** | //έντελο LDAX |
| m0e | **06** | //opcode STA |
| m0f | **11** | //έντελο STA |
| m10 | **04** | //opcode LDA K(X) |
| m11 | **0c** | //έντελο LDA K(X) |
| m12 | **06** | //opcode STA |
| m13 | **12** | //έντελο STA |
| m14 | **05** | //opcode MOVEAX |
| m15 | **06** | //opcode STA |
| m16 | **13** | //έντελο STA |
| m17 |  | //περιοχή δεδομένων |

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| **Mapper** | | |
| Κώδικας εντολής | Opcode | Περιεχόμενα |
| LDA #K | **m00** | 02 |
| LDX #K | **m01** | 06 |
| LDA ($K) | **m02** | 0a |
| LDAX | **m03** | 10 |
| LDA K(X) | **m04** | 15 |
| MOVEAX | **m05** | 1a |
| STA $K | **m06** | 23 |
| STX $K | **m07** | 1E |