**ΑΣΚΗΣΗ 2**

Accumulator: 0011

Pc: 1100

X: 0110

**LDA #K** //φόρτωσε στον συσσωρευτή τον διψήφιο δεκαεξαδικό αριθμό Κ

**PC + 1 -> PC, MAR** // Το Κ στο MDR

**MDR + 0 -> ACC** // Το Κ 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)**

**STX $K** // αποθήκευση το περιεχόμενο του Χ στη θέση μνήμη με διεύθυνση Κ

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

**MDR + 0 -> NOP, MAR**

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

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

**NEXT(PC)**

**LDA ($K)** // φόρτωσε στον συσσωρευτή το περιεχόμενο της θέσης μνήμης με διεύθυνση το περιεχόμενο της θέσης μνήμης με διεύθυνση Κ

**PC + 1 -> PC, MAR** // Το Κ στο MDR

**MDR + 0 -> NOP, MAR** // Τo Κ στον MAR, άρα το περιεχόμενο του Κ στον MDR

**MDR + 0 -> NOP, MAR** // Τo Κ στον MAR, άρα το περιεχόμενο του Κ στον MDR

**MDR + 0 -> ACC** // Το περιεχόμενο του Κ πάει στον accumulator

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

**NEXT(PC)**

**LDAX** //φόρτωσε στον συσσωρευτή το περιεχόμενο της θέσης μνήμης με διεύθυνση το περιεχόμενο του καταχωρητή Χ

**PC + 1 -> PC, MAR** // Το Κ στο MDR

**Χ + 0 -> MAR** // Τo Χ στον MAR, άρα το περιεχόμενο του Χ στον MDR

**MDR + 0 -> ACC** // Το περιεχόμενό του Χ πάει στον accumulator

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

**NEXT(PC)**

**LDA Κ(X)**

**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)**

**MOVEAX** // το περιεχόμενο του καταχωρητή Χ στον συσσωρευτή

**Χ + 0 -> ACC** // το περιεχόμενο του Χ στον ACC

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

**NEXT(PC)**

**STA $K** //αποθήκευσε το περιεχόμενο του συσσωρευτή στη θέση μνήμης με διεύθυνση Κ

**PC + 1 -> PC, MAR** //Τo K θα πάει στον MDR

**MDR + 0 -> NOP, MAR** //Τo Κ στον MAR, άρα το περιεχόμενο του Κ στον MDR

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

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

**NEXT(PC)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **BOOTSTRAP** | 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) |  |  |  |  |  |  |  |  |  |  |  |
| SW+0->PC,MAR | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 1100 | 00 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | m00 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | m01 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **LDA #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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | m02 |
| MDR+0->ACC | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 0011 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | m03 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | m04 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | m05 |

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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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M06 |
| MDR+0->X | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 0110 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | M07 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M08 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M09 |

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| **LDΑ ($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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M0A |
| MDR+0->NOP, MAR | XXXXX | 000 | XXX | 111 | 000 | 001 | XXXX | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | M0B |
| MDR+0->NOP, MAR | XXXXX | 000 | XXX | 111 | 000 | 001 | XXXX | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | M0C |
| MDR+0->ACC | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 0011 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | M0D |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M0E |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M0F |

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| **LDAX** | 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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M10 |
| X+0-> MAR | XXXXX | 000 | XXX | 100 | 000 | 011 | 0110 | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | M11 |
| MDR+0->ACC | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 0011 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | M12 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M13 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M14 |

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| **LDA Κ(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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M15 |
| MDR+X ->NOP,MAR | XXXXX | 000 | XXX | 101 | 000 | 001 | 0110 | XXXX | XX | X | X | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | M16 |
| MDR+0->ACC | XXXXX | 000 | XXX | 111 | 000 | 011 | XXXX | 0011 | XX | X | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | M17 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M18 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M19 |

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| **MOVEAX** | 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) |  |  |  |  |  |  |  |  |  |  |  |
| Χ + 0 -> ACC | XXXXX | 000 | XXX | 100 | 000 | 001 | 0110 | 0011 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M1A |
| PC + 1 -> PC, MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M1B |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | x | X | X | X | M1C |

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| **STX $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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M1E |
| MDR+0->NOP,MAR | XXXXX | 000 | XXX | 111 | 000 | 001 | XXXX | XXXX | XX | X | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | M1F |
| X + 0 -> NOP, MWE~ | XXXXX | 000 | XXX | 100 | 000 | 001 | 0110 | XXXX | XX | X | X | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | M20 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M21 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M22 |

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| **STA $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 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M23 |
| MDR+0->NOP,MAR | XXXXX | 000 | XXX | 111 | 000 | 001 | XXXX | XXXX | XX | X | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | M24 |
| ACC+0->NOP,MWE | XXXXX | 000 | XXX | 100 | 000 | 001 | 0011 | XXXX | XX | X | X | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | M25 |
| PC+1->PC,MAR | XXXXX | 000 | XXX | 101 | 000 | 011 | 1100 | 1100 | 01 | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | M26 |
| NEXT(PC) | XXXXX | 000 | XXX | XXX | XXX | 001 | XXXX | XXXX | XX | X | X | 1 | 0 | 0 | 0 | X | X | X | X | M27 |

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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 |

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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 |