**1 – Ternary definition and structure**

The minimal trinary unit is the « trit », one trit can have 3 logic state 1, 0 and -1 (T, U, F).

9 trit together represent a tryte, it’s equivalent to the byte in binary. A Tword is composed of 3 tryte (27 trit).

**2 – Register and Flag**

There is 4 general purpose register (A , B, C, D) and a 1 stack pointer register (SP)

Register can store 1 Tword value, but are addressed on 1 tryte

EA = D + A  
EB = A + B

EC = B + C

ED = C + D

There is one more register for flag strorage, also in 1Tword size,

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **26** | **25** | **24** | **23** | **22** | **21** | **20** | **19** | **18** | **17** | **16** | **15** | **14** | **13** | **12** | **11** | **10** | **9** | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | OF | DF |  | TF | SF | ZF |  | AF |  | PF |  | CF |

CF – Carry Flag

PF – Parity Flag

AF – Adjust Flag

ZF – Zero Flag

SF – Sign Flag

DF – Direction Flag

OF – Overflow Flag

**3 – Opcodes**

All opcode is codded in 1tryte, argument number and size may vary.

| **OPCODE** | **Action** | **Value** | **Args** | **Args Size** | **SIZE** |
| --- | --- | --- | --- | --- | --- |
| NOP |  | -1 | - | - |  |
| HLT |  | 0 | - | - |  |
| MOV | register to register | 1 | REG, REG | Tryte, Tryte | 3 |
|  | Register address to register | 2 | REG, [REG] | Tryte, Tryte | 3 |
|  | Address to register | 3 | REG, [ADDR] | Tryte, Tryte | 3 |
|  | Number to register | 4 | REG, CONS | Tryte, Tryte | 3 |
|  | Register to register address | 5 | [REG], REG | Tryte, Tryte | 3 |
|  | Number to register address | 6 | [REG], CONS | Tryte, Tryte | 3 |
|  | Register to address | 7 | [ADDR], REG | Tryte, Tryte | 3 |
|  | Number to address | 8 | [ADDR], CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| DB |  | <10> | CONS |  |  |
|  |  | 11 |  |  |  |
|  |  | 12 |  |  |  |
|  |  | 13 |  |  |  |
|  |  | 14 |  |  |  |
|  |  | 15 |  |  |  |
|  |  | 16 |  |  |  |
|  |  | 17 |  |  |  |
|  |  | 18 |  |  |  |
|  |  | 19 |  |  |  |
| CMP |  | 20 | REG, REG | Tryte, Tryte | 3 |
|  |  | 21 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 22 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 23 | REG, CONS | Tryte, Tryte | 3 |
| JMP | Jump to address | 30 | REG | Tryte | 2 |
|  |  | 31 | ADDR | Tryte | 2 |
| JC | Jump to address if Carry = T | 32 | REG | Tryte | 2 |
|  |  | 33 | ADDR | Tryte | 2 |
| JNC | Jump to address if Carry = F | 34 | REG | Tryte | 2 |
|  |  | 35 | ADDR | Tryte | 2 |
| JUC | Jump to address if Carry = U | 36 | REG | Tryte | 2 |
|  |  | 37 | ADDR | Tryte | 2 |
| JZ | Jump to address if Zero = T | 38 | REG | Tryte | 2 |
|  |  | 39 | ADDR | Tryte | 2 |
| JNZ | Jump to address if Zero = F | 40 | REG | Tryte | 2 |
|  |  | 41 | ADDR | Tryte | 2 |
| JUZ | Jump to address if Zero = U | 42 | REG | Tryte | 2 |
|  |  | 43 | ADDR | Tryte | 2 |
|  |  | 44 |  |  |  |
|  |  | 45 |  |  |  |
|  |  | 46 |  |  |  |
|  |  | 47 |  |  |  |
|  |  | 48 |  |  |  |
|  |  | 49 |  |  |  |
| PUSH | Push to the Stack | 50 | REG | Tryte | 2 |
|  |  | 51 | [REG] | Tryte | 2 |
|  |  | 52 | [ADDR] | Tryte | 2 |
|  |  | 53 | CONS | Tryte | 2 |
| POP | Pop to register | 54 | REG | Tryte | 2 |
| CALL |  | 55 | REG | Tryte | 2 |
|  |  | 56 | ADDR | Tryte | 2 |
| RET |  | 57 | - | - | 1 |
|  |  | 58 |  |  |  |
|  |  | 59 |  |  |  |
| INC | Increment register by 1 | 60 | REG | Tryte | 2 |
| DEC | Decrement register by 1 | 61 | REG | Tryte | 2 |
| ADD |  | 70 | REG, REG | Tryte, Tryte | 3 |
|  |  | 71 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 72 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 73 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| SUB |  | 75 | REG, REG | Tryte, Tryte | 3 |
|  |  | 76 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 77 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 78 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| MUL |  | 80 | REG, REG | Tryte, Tryte | 3 |
|  |  | 81 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 82 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 83 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| DIV |  | 85 | REG, REG | Tryte, Tryte | 3 |
|  |  | 86 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 87 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 88 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| AND |  | 90 | REG, REG | Tryte, Tryte | 3 |
|  |  | 91 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 92 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 93 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| OR |  | 95 | REG, REG | Tryte, Tryte | 3 |
|  |  | 96 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 97 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 98 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| XOR |  | 100 | REG, REG | Tryte, Tryte | 3 |
|  |  | 101 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 102 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 103 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| NOT |  | 105 | REG | Tryte | 2 |
| NOTT |  | 106 | REG | Tryte | 2 |
| NOTF |  | 107 | REG | Tryte | 2 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| SHL |  | 110 | REG, REG | Tryte, Tryte | 3 |
|  |  | 111 | REG, [REG] | Tryte, Tryte | 3 |
|  |  | 112 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 113 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
| SHR |  | 115 | REG, REG | Tryte, Tryte | 3 |
|  |  | 116 | REG, [REG] | Tryte, Tryte | 5 |
|  |  | 117 | REG, [ADDR] | Tryte, Tryte | 3 |
|  |  | 118 | REG, CONS | Tryte, Tryte | 3 |
|  |  |  |  |  |  |
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