**GROUP 7 WORK**

SPECIFACATION 7

HERE B’s INPUT = TEMP

|  |  |  |  |
| --- | --- | --- | --- |
| S2 | S1 | S0 | Operation |
| 0 | 0 | 0 | A – B |
| 0 | 0 | 1 | A + 1 |
| 0 | 1 | 0 | A – 1 |
| 0 | 1 | 1 | A + B |
| 1 | 0 | 0 | A∙B |
| 1 | 0 | 1 | A or B |
| 1 | 1 | 0 | Ā |
| 1 | 1 | 1 | A ⊕ B |

**Micro programming**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Opcode | Macro instruction | T state | Micro operation | Active | CON |
|  | ALL | T1 | MAR = PC | Ep, Lm | 30000h |
| T2 | PC = PC + 1 | Cp | 80000h |
| T3 | IR = RAM[ MAR ] | CE, Li | 0C000h |
| 0H | LDA address | T4 | MAR = IR(3..0) | Lm, Ei | 12000h |
| T5 | A = RAM [ MAR ] | CE, La | 09000h |
| T6 | None | None | 00000h |
| 1H | MOV C, A | T4 | C = A | Lc, Ea | 00804h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| 2H | MOV A,B | T4 | A = B | La, Eb | 01008h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| 3H | MVI B, byte | T4 | B = IR(3..0) | Ei, Lb | 02010h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| 4H | SUI byte | T4 | TEMP = IR(3..0) | Ei, Lt | 02020h |
| T5 | A = ALU( A-TEMP ) | Eu, La | 01040h |
| T6 | None | None | 00000h |
| 5H | DCR A | T4 | A = ALU(A-1) | Eu, La, S1 | 01140h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| 6H | XRA C | T4 | TEMP = C | Ec, Lt | 00022h |
| T5 | A = ALU(A XOR TEMP) | S2, S1, S0, Eu, La | 013C0h |
| T6 | None | None | 00000h |
| 7H | ORA B | T4 | TEMP = B | Lt, Eb | 00028h |
| T5 | A = ALU( A OR TEMP ) | S2, S0, Eu, La | 012C0h |
| T6 | None | None | 00000h |
| 8H | ANA C | T4 | TEMP = C | Lt, Ec | 00022h |
| T5 | A = ALU( A AND TEMP) | S2, Eu, La | 01240h |
| T6 | None | None | 00000h |
| 9H | XRI byte | T4 | TEMP = IR(3..0) | Lt, Ei | 02020h |
| T5 | A = ALU( A XOR TEMP) | S2, S1, S0, Eu, La | 013C0h |
| T6 | None | None | 00000h |
| AH | CMA | T4 | A = ALU(A’) | S2, S1, Eu, La | 01340h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| BH | MUL2 | T4 | A = SHR A | Ea, Sa | 00C00h |
| T5 | None | none | 00000h |
| T6 | None | None | 00000h |
| CH | JMP address | T4 | PC = IR(3..0) | Ei, Lp | 42000h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| DH | OUT | T4 | OUT = A | Lo, Ea | 00801h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| EH | NOP | T4 | None | None | 00000h |
| T5 | None | None | 00000h |
| T6 | None | None | 00000h |
| FH | HLT | T3 | None | HLT’ | 00000h |

CON FINDING TABLE

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Opcode | Macro instruction | T state | Cp,LP,Ep,Lm | CE,Li,Ei,La | Ea,Sa,S2,S1 | S0,Eu,Lt,Lb | Eb,Lc,Ec,Lo | HEX Value |
|  | ALL | T1 | 0 0 1 1 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 30000h |
| T2 | 1 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 80000h |
| T3 | 0 0 0 0 | 1 1 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0C000h |
| 0H | LDA address | T4 | 0 0 0 1 | 0 0 1 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 12000h |
| T5 | 0 0 0 0 | 1 0 0 1 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 09000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 1H | MOV C, A | T4 | 0 0 0 0 | 0 0 0 0 | 1 0 0 0 | 0 0 0 0 | 0 1 0 0 | 00804h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 2H | MOV A,B | T4 | 0 0 0 0 | 0 0 0 1 | 0 0 0 0 | 0 0 0 0 | 1 0 0 0 | 01008h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 3H | MVI B, byte | T4 | 0 0 0 0 | 0 0 1 0 | 0 0 0 0 | 0 0 0 1 | 0 0 0 0 | 02010h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 4H | SUI byte | T4 | 0 0 0 0 | 0 0 1 0 | 0 0 0 0 | 0 0 1 0 | 0 0 0 0 | 02020h |
| T5 | 0 0 0 0 | 0 0 0 1 | 0 0 0 0 | 0 1 0 0 | 0 0 0 0 | 01040h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 5H | DCR A | T4 | 0 0 0 0 | 0 0 0 1 | 0 0 0 1 | 0 1 0 0 | 0 0 0 0 | 01140h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 6H | XRA C | T4 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 1 0 | 0 0 1 0 | 00022h |
| T5 | 0 0 0 0 | 0 0 0 1 | 0 0 1 1 | 1 1 0 0 | 0 0 0 0 | 013C0h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 7H | ORA B | T4 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 1 0 | 1 0 0 0 | 00028h |
| T5 | 0 0 0 0 | 0 0 0 1 | 0 0 1 0 | 1 1 0 0 | 0 0 0 0 | 012C0h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 8H | ANA C | T4 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 1 0 | 0 0 1 0 | 00022h |
| T5 | 0 0 0 0 | 0 0 0 1 | 0 0 1 0 | 0 1 0 0 | 0 0 0 0 | 01240h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| 9H | XRI byte | T4 | 0 0 0 0 | 0 0 1 0 | 0 0 0 0 | 0 0 1 0 | 0 0 0 0 | 02020h |
| T5 | 0 0 0 0 | 0 0 0 1 | 0 0 1 1 | 1 1 0 0 | 0 0 0 0 | 013C0h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| AH | CMA | T4 | 0 0 0 0 | 0 0 0 1 | 0 0 1 1 | 0 1 0 0 | 0 0 0 0 | 01340h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| BH | MUL2 | T4 | 0 0 0 0 | 0 0 0 0 | 1 1 0 0 | 0 0 0 0 | 0 0 0 0 | 00C00h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| CH | JMP address | T4 | 0 1 0 0 | 0 0 1 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 42000h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| DH | OUT | T4 | 0 0 0 0 | 0 0 0 0 | 1 0 0 0 | 0 0 0 0 | 0 0 0 1 | 00801h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| EH | NOP | T4 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T5 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| T6 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |
| FH | HLT | T3 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 00000h |

**Here no instruction has any work on T6 state so we can remove it. And so there is 5 T states.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Opcode | Macro instruction | T state | Micro operation | Active | CON |
|  | Fetch | T1 | MAR = PC | Ep, Lm | 30000h |
| T2 | PC = PC + 1 | Cp | 80000h |
| T3 | IR = RAM[ MAR ] | CE, Li | 0C000h |
| 0H | LDA address | T4 | MAR = IR(3..0) | Lm, Ei | 12000h |
| T5 | A = RAM [ MAR ] | CE, La | 09000h |
| 1H | MOV C, A | T4 | C = A | Lc, Ea | 00804h |
| T5 | None | None | 00000h |
| 2H | MOV A,B | T4 | A = B | La, Eb | 01008h |
| T5 | None | None | 00000h |
| 3H | MVI B, byte | T4 | B = IR(3..0) | Ei, Lb | 02010h |
| T5 | None | None | 00000h |
| 4H | SUI byte | T4 | TEMP = IR(3..0) | Ei, Lt | 02020h |
| T5 | A = ALU( A-TEMP ) | Eu, La | 01040h |
| 5H | DCR A | T4 | A = ALU(A-1) | Eu, La, S1 | 01140h |
| T5 | None | None | 00000h |
| 6H | XRA C | T4 | TEMP = C | Ec, Lt | 00022h |
| T5 | A = ALU(A XOR TEMP) | S2, S1, S0, Eu, La | 013C0h |
| 7H | ORA B | T4 | TEMP = B | Lt, Eb | 00028h |
| T5 | A = ALU( A OR TEMP ) | S2, S0, Eu, La | 012C0h |
| 8H | ANA C | T4 | TEMP = C | Lt, Ec | 00022h |
| T5 | A = ALU( A AND TEMP) | S2, Eu, La | 01240h |
| 9H | XRI byte | T4 | TEMP = IR(3..0) | Lt, Ei | 02020h |
| T5 | A = ALU( A XOR TEMP) | S2, S1, S0, Eu, La | 013C0h |
| AH | CMA | T4 | A = ALU(A’) | S2, S1, Eu, La | 01340h |
| T5 | None | None | 00000h |
| BH | MUL2 | T4 | A = SHL A | Ea, Sa | 00C00h |
| T5 | None | None | 00000h |
| CH | JMP address | T4 | PC = IR(3..0) | Ei, Lp | 42000h |
| T5 | None | None | 00000h |
| DH | OUT | T4 | OUT = A | Lo, Ea | 00801h |
| T5 | None | None | 00000h |
| EH | NOP | T4 | None | None | 00000h |
| T5 | None | None | 00000h |
| FH | HLT | T3 | None | HLT’ | 00000h |

Here, h = 0x = hexadecimal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Opcode | Macro instruction | T state | Address | CON | CON\_1 | CON\_2 | CON\_3 |
|  | Fetch | T1 | 00h | 30000h | 0x30 | 0x00 | 0x0 |
| T2 | 01h | 80000h | 0x80 | 0x00 | 0x0 |
| T3 | 02h | 0C000h | 0x0C | 0x00 | 0x0 |
| 0H | LDA address | T4 | 03h | 12000h | 0x12 | 0x00 | 0x0 |
| T5 | 04h | 09000h | 0x09 | 0x00 | 0x0 |
| 1H | MOV C, A | T4 | 05h | 00804h | 0x00 | 0x80 | 0x4 |
| T5 | 06h | 00000h | 0x00 | 0x00 | 0x0 |
| 2H | MOV A,B | T4 | 07h | 01008h | 0x01 | 0x00 | 0x8 |
| T5 | 08h | 00000h | 0x00 | 0x00 | 0x0 |
| 3H | MVI B, byte | T4 | 09h | 02010h | 0x02 | 0x01 | 0x0 |
| T5 | 0Ah | 00000h | 0x00 | 0x00 | 0x0 |
| 4H | SUI byte | T4 | 0Bh | 02020h | 0x02 | 0x02 | 0x0 |
| T5 | 0Ch | 01040h | 0x01 | 0x04 | 0x0 |
| 5H | DCR A | T4 | 0Dh | 01140h | 0x01 | 0x14 | 0x0 |
| T5 | 0Eh | 00000h | 0x00 | 0x00 | 0x0 |
| 6H | XRA C | T4 | 0Fh | 00022h | 0x00 | 0x02 | 0x2 |
| T5 | 10h | 013C0h | 0x01 | 0x3C | 0x0 |
| 7H | ORA B | T4 | 11h | 00028h | 0x00 | 0x02 | 0x8 |
| T5 | 12h | 012C0h | 0x01 | 0x2C | 0x0 |
| 8H | ANA C | T4 | 13h | 00022h | 0x00 | 0x02 | 0x2 |
| T5 | 14h | 01240h | 0x01 | 0x24 | 0x0 |
| 9H | XRI byte | T4 | 15h | 02020h | 0x02 | 0x02 | 0x0 |
| T5 | 16h | 013C0h | 0x01 | 0x3C | 0x0 |
| AH | CMA | T4 | 17h | 01340h | 0x01 | 0x34 | 0x0 |
| T5 | 18h | 00000h | 0x00 | 0x00 | 0x0 |
| BH | MUL2 | T4 | 19h | 00C00h | 0x00 | 0xC0 | 0x0 |
| T5 | 1Ah | 00000h | 0x00 | 0x00 | 0x0 |
| CH | JMP address | T4 | 1Bh | 42000h | 0x42 | 0x00 | 0x0 |
| T5 | 1Ch | 00000h | 0x00 | 0x00 | 0x0 |
| DH | OUT | T4 | 1Dh | 00801h | 0x00 | 0x80 | 0x1 |
| T5 | 1Eh | 00000h | 0x00 | 0x00 | 0x0 |
| EH | NOP | T4 | 1Fh | 00000h | 0x00 | 0x00 | 0x0 |
| T5 | 20h | 00000h | 0x00 | 0x00 | 0x0 |
| FH | HLT | T3 | 21h | 00000h | 0x00 | 0x00 | 0x0 |

Rom address hex

|  |  |  |
| --- | --- | --- |
| ROM ADDRESS | Contents | Routine |
| 0H | 0x03 | LDA address |
| 1H | 0x05 | MOV C, A |
| 2H | 0x07 | MOV A,B |
| 3H | 0x09 | MVI B, byte |
| 4H | 0x0B | SUI byte |
| 5H | 0x0D | DCR A |
| 6H | 0x0F | XRA C |
| 7H | 0x11 | ORA B |
| 8H | 0x13 | ANA C |
| 9H | 0x15 | XRI byte |
| AH | 0x17 | CMA |
| BH | 0x19 | MUL2 |
| CH | 0x1B | JMP address |
| DH | 0x1D | OUT |
| EH | 0x1F | NOP |
| FH | 0x21 | HLT |

|  |  |
| --- | --- |
| **Opcode** | **Operation** |
| 0H | LDA address |
| 1H | MOV C, A |
| 2H | MOV A, B |
| 3H | MVI B, byte |
| 4H | SUI byte |
| 5H | DCR A |
| 6H | XRA C |
| 7H | ORA B |
| 8H | ANA C |
| 9H | XRI byte |
| AH | CMA |
| BH | MUL2 |
| CH | JMP address |
| DH | OUT |
| EH | NOP |
| FH | HLT |

Instructions Group 7 Programming section:

|  |  |  |
| --- | --- | --- |
| **Opcode** | **Assembly** | **Hexcode** |
| 0H | LDA Ah | 0x0A |
| 1H | DCR A | 0x50 |
| 2H | MOV C, A | 0x20 |
| 3H | ANA C | 0x80 |
| 4H | OUT | 0xD0 |
| 5H | HLT | 0xF0 |
| 6H | FFH | 0xFF |
| 7H | FFH | 0xFF |
| 8H | FFH | 0xFF |
| 9H | FFH | 0xFF |
| AH | 05H | 0x05 |
| BH | FFH | 0xFF |
| CH | FFH | 0xFF |
| DH | FFH | 0xFF |
| EH | FFH | 0xFF |
| FH | FFH | 0xFF |

