**INSTRUCTION FORMAT**

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| Opcode (5 bit) | Addressing Mode (3) | Oprand (8) |

**Memory Addressing Mode**

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| Addressing mode | Machine Code | Example instruction | Meaning |
| Immediate | 000 | ADD value | ACC <= ACC+ X |
| Direct | 001 | ADD @value | ACC <= ACC+ MEM[X] |
| Indirect | 010 | ADD #value | ACC <= ACC+ MEM[MEM[X]] |

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| OP Code | Assembly Language Instruction | RTL Description | Documentation | NOTE\*\*\* |
| 00000 | ADD X | ACC=ACC + X | Perform the ALU operation as described in the column to the left between the value in the Accumulator and the direct/indirect memory address value or the immediate value. |  |
| 00001 | SUB X | ACC=ACC-X |  |
| 00010 | OR X | ACC=ACC or X |  |
| 00011 | ORNOT X | ACC=ACC or ~X |  |
| 00100 | AND X | ACC=ACC or X |  |
| 00101 | ANDNOT X | ACC=ACC and ~X |  |
| 00110 | COMPACC | ACC= ~ACC | Complement the value in the Accumulator, then store the value back into the Accumulator. |  |
| 00111 | COMP X | ACC= ~X | Complement direct/indirect memory address value or the immediate value, then store the value back into the Accumulator. |  |
| 01000 | LOAD X | ACC= X | Load the Oprand into the Accumulator. |  |
| 01001 | STR X | MEM[X] = ACC | Store the value in the Accumulator to the Memory location X. | Only work when X is immediate addr mode |
| 01010 | SHIFTL | ACC= ACC<<1 | Left shift the value in the Accumulator. | No Oprand needed. |
| 01011 | SHIFTR | ACC= ACC>>1 | Right shift the value in the Accumulator. |
| 01100 | INPUT | ACC = Bus | Load the value from the bus into the Accumulator with two-way hand shaking protocol utilized. |  |
| 01101 | OUTPUT | Bus = ACC | Output the value in the Accumulator to the Bus with two-way hand shaking protocol utilized. |  |
| 01111 | MASKHVPI X | MASKHVPI = X | Mask the value in the HVPI Register with the value X.  When the HVPI Reg has the value:  0001 overflow interrupt has the highest priority.  0010 Bad Instruction interrupt has the highest priority.  0100 Bad Addressing Mode interrupt has the highest priority.  1000 External interrupt has the highest priority.  If the HVPI Reg is not set,  the priority will be given in this order:  Overflow,  Bad Insturction,  Bad Addressing Mode,  External Interrupt. |  |
| 11000 | MUL X | ACC=ACC\*X | Multiply the value in the Accumulator with the Oprand. Then put the result back in the Accumulator. | Only work when X is immediate addr mode |
| 11001 | DIV X | ACC=ACC/X | Divide the value in the Accumulator with the Oprand. Then put the result back in the Accumulator. |
| 11010 | BRANCH X | ProCounter = X | Branch/Jump to the instruction address X. |
| 11011 | BRZERO X | If(ZeroFlag==1)  ProCounter =X | If zero flag is 1, then branch to the instruction address X. |
| 11100 | JUMPSUB X | SubAddrReg = ProCounter  ProCounter = X | Save the current Program Counter. Then jump to the subroutine. The subroutine address is provided in the Oprand. |
| 11101 | RETURNSUB | ProCounter = SubAddrReg | Return from the subroutine. This is done by loading the value from SubAddrReg into the Program Counter. | No Oprand value needed. |
| 11110 | RETURNITR | ProCounter = ItrAddrReg | Return from the interrupt service routine. This is done by loading the value from ItrAddrReg into the Program Counter. |

**Example**

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| Assembly Code | ADD @9 |
| Machine Code | 00000 001 00001001 (There will be no spaces in the real program) |
| Explanation | Add the value in the accumulator with the value at the Data Ram address location 9 |

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| Assembly Code | ADD 3 |
| Machine Code | 00000 000 00000011 |
| Explanation | Add the value in the accumulator with 3. |

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| Assembly Code | RETURNSUB |
| Machine Code | 11110 DDD DDDDDDDD ( ‘D’ means “Don’t Cares.” It can be 1 or 0, it won’t matter.) |
| Explanation | Put the value from the SubAddrReg into the program counter. |