A. **Appendix for as8096 Frankenstein Assembler**

A.1 **Pseudo Operations**

A.1.1 *Standard_Pseudo_Operation_Mnemonics*

```
End                                  END
File Inclusion                       INCL INCLUDE
If                                   IF
Else                                 ELSE
End If                               ENDI
Equate                               EQU
Set                                  SET
Org                                  ORG
Reserve Memory                       DSB RESERVE RMB
Define Byte Data                     BYTE DCB FCB
Define String Data                   FCC STRING
Define Character Set Translation     CHARSET
Define Character Value               CHARDEF CHD
Use Character Translation            CHARUSE
```

A.1.2 *Machine_Dependent_Pseudo_Operations*

A.1.2.1 *Define_Word_Data,_Aligned*

```
[Label]  WORD  expression [, expression] ...
[Label]  FDB   expression [, expression] ...
[Label]  DCW   expression [, expression] ...
```

The define word statement generates a two byte integer for
each expression in the expression list. There can be up to
128 expressions on a line, more than the line length will
allow. The location counter is adjusted by skipping bytes
to make the first location address divisible by 2. The
generated constants are in byte reversed order, with the low
order byte first, followed by the high order byte. The
optional label is set to the first location of this area.

A.1.2.2 *Define_Long_Word_Data,_Aligned*

```
[Label]  LONG  expression [, expression] ...
[Label]  DCL   expression [, expression] ...
```

The define long word statement generates a four byte integer
for each expression in the expression list. There can be up
to 128 expressions on a line, more than the line length will
allow. The location counter is adjusted by skipping bytes
to make the first location address divisible by 4. The
generated constants are in byte reversed order, with the low
order byte first, followed by the high order bytes. The
optional label is set to the first location of this area.

A.1.2.3 *Reserve_Memory,_Word_Aligned*

    [Label] DSW expression

This statement moves the location counter forward by the
number of bytes specified in the expression. The location
counter is adjusted by skipping bytes to make the first
location address divisible by 2. The label is set to the
first location of this area.

A.1.2.4 *Reserve_Memory,_Long_Word_Aligned*

    [Label] DSL expression

This statement moves the location counter forward by the
number of long words specified in the expression. The
location counter is adjusted by skipping bytes to make the
first location address divisible by 4. The label is set to
the first location of this area.

A.1.2.5 *Instruction_Set_Selection*

    CPU string

The instruction set can be specified in the source file with
the CPU pseudooperation. The string, delimited by quotes or
apostrophes, is scanned for a substring which selects which
instruction set is used. When the program is invoked, this
operation is performed on the name of the program, then the
-p optional arguement, if any, and then any CPU statements.
The last one selects which subset of the instructions the
assembler will accept. The instruction set can be changed
at any place in the source file.

Instruction Set	Substrings
80c196	19
8096	9

A.2 **Instructions**

A.2.1 *Instruction_List*

Opcode	Syntax	Selection Criteria
ADD	expr ',' '#' expr	
ADD	expr ',' '[' expr ']'	
ADD	expr ',' expr ',' '#' expr	
ADD	expr ',' expr ',' '[' expr ']'	
ADD	expr ',' expr ',' expr '[' expr ']'	DIRECT
ADD	expr ',' expr ',' expr '[' expr ']'	EXTENDED

```
Opcode     Syntax                                        Selection Criteria

ADD        expr ',' expr ',' expr                        DIRECT
ADD        expr ',' expr ',' expr                        EXTENDED
ADD        expr ',' expr '[' expr ']'                    DIRECT
ADD        expr ',' expr '[' expr ']'                    EXTENDED
ADD        expr ',' expr                                 DIRECT
ADD        expr ',' expr                                 EXTENDED

ADDB       expr ',' '#' expr
ADDB       expr ',' '[' expr ']'
ADDB       expr ',' expr ',' '#' expr
ADDB       expr ',' expr ',' '[' expr ']'
ADDB       expr ',' expr ',' expr '[' expr ']'   DIRECT
ADDB       expr ',' expr ',' expr '[' expr ']'   EXTENDED
ADDB       expr ',' expr ',' expr                        DIRECT
ADDB       expr ',' expr ',' expr                        EXTENDED
ADDB       expr ',' expr '[' expr ']'                    DIRECT
ADDB       expr ',' expr '[' expr ']'                    EXTENDED
ADDB       expr ',' expr                                 DIRECT
ADDB       expr ',' expr                                 EXTENDED

ADDC       expr ',' '#' expr
ADDC       expr ',' '[' expr ']'
ADDC       expr ',' expr '[' expr ']'                    DIRECT
ADDC       expr ',' expr '[' expr ']'                    EXTENDED
ADDC       expr ',' expr                                 DIRECT
ADDC       expr ',' expr                                 EXTENDED

ADDCB      expr ',' '#' expr
ADDCB      expr ',' '[' expr ']'
ADDCB      expr ',' expr '[' expr ']'                    DIRECT
ADDCB      expr ',' expr '[' expr ']'                    EXTENDED
ADDCB      expr ',' expr                                 DIRECT
ADDCB      expr ',' expr                                 EXTENDED

AND        expr ',' '#' expr
AND        expr ',' '[' expr ']'
AND        expr ',' expr ',' '#' expr
AND        expr ',' expr ',' '[' expr ']'
AND        expr ',' expr ',' expr '[' expr ']'   DIRECT
AND        expr ',' expr ',' expr '[' expr ']'   EXTENDED
AND        expr ',' expr ',' expr                        DIRECT
AND        expr ',' expr ',' expr                        EXTENDED
AND        expr ',' expr '[' expr ']'                    DIRECT
AND        expr ',' expr '[' expr ']'                    EXTENDED
AND        expr ',' expr                                 DIRECT
AND        expr ',' expr                                 EXTENDED

ANDB       expr ',' '#' expr
ANDB       expr ',' '[' expr ']'
```

```
Opcode     Syntax                                    Selection Criteria

ANDB       expr ',' expr ',' '#' expr
ANDB       expr ',' expr ',' '[' expr ']'
ANDB       expr ',' expr ',' expr '[' expr ']'    DIRECT
ANDB       expr ',' expr ',' expr '[' expr ']'    EXTENDED
ANDB       expr ',' expr ',' expr                 DIRECT
ANDB       expr ',' expr ',' expr                 EXTENDED
ANDB       expr ',' expr '[' expr ']'             DIRECT
ANDB       expr ',' expr '[' expr ']'             EXTENDED
ANDB       expr ',' expr                          DIRECT
ANDB       expr ',' expr                          EXTENDED

BMOV       expr ',' expr                          CPU196

BR         '[' expr ']'

CLR        expr

CLRB       expr

CLRC

CLRVT

CMP        expr ',' '#' expr
CMP        expr ',' '[' expr ']'
CMP        expr ',' expr '[' expr ']'             DIRECT
CMP        expr ',' expr '[' expr ']'             EXTENDED
CMP        expr ',' expr                          DIRECT
CMP        expr ',' expr                          EXTENDED

CMPB       expr ',' '#' expr
CMPB       expr ',' '[' expr ']'
CMPB       expr ',' expr '[' expr ']'             DIRECT
CMPB       expr ',' expr '[' expr ']'             EXTENDED
CMPB       expr ',' expr                          DIRECT
CMPB       expr ',' expr                          EXTENDED

CMPL       expr ',' expr                          CPU196

DEC        expr

DECB       expr

DI

DIV        expr ',' '#' expr
DIV        expr ',' '[' expr ']'
DIV        expr ',' expr '[' expr ']'             DIRECT
DIV        expr ',' expr '[' expr ']'             EXTENDED
```

```
Opcode     Syntax                                    Selection Criteria

DIV        expr ',' expr                             DIRECT
DIV        expr ',' expr                             EXTENDED

DIVB       expr ',' '#' expr
DIVB       expr ',' '[' expr ']'
DIVB       expr ',' expr '[' expr ']'                DIRECT
DIVB       expr ',' expr '[' expr ']'                EXTENDED
DIVB       expr ',' expr                             DIRECT
DIVB       expr ',' expr                             EXTENDED

DIVU       expr ',' '#' expr
DIVU       expr ',' '[' expr ']'
DIVU       expr ',' expr '[' expr ']'                DIRECT
DIVU       expr ',' expr '[' expr ']'                EXTENDED
DIVU       expr ',' expr                             DIRECT
DIVU       expr ',' expr                             EXTENDED

DIVUB      expr ',' '#' expr
DIVUB      expr ',' '[' expr ']'
DIVUB      expr ',' expr '[' expr ']'                DIRECT
DIVUB      expr ',' expr '[' expr ']'                EXTENDED
DIVUB      expr ',' expr                             DIRECT
DIVUB      expr ',' expr                             EXTENDED

DJNZ       expr ',' expr

DJNZW      expr ',' expr                             CPU196

EI

EXT        expr

EXTB       expr

IDLPD      '#' expr                                  CPU196

INC        expr

INCB       expr

JBC        expr ',' expr ',' expr

JBS        expr ',' expr ',' expr

JC         expr

JE         expr

JGE        expr
```

```
Opcode     Syntax                                        Selection Criteria


JGT        expr

JH         expr

JLE        expr

JLT        expr

JNC        expr

JNE        expr

JNH        expr

JNST       expr

JNV        expr

JNVT       expr

JST        expr

JV         expr

JVT        expr

LCALL      expr

LD         expr ',' '#' expr
LD         expr ',' '[' expr ']'
LD         expr ',' expr '[' expr ']'          DIRECT
LD         expr ',' expr '[' expr ']'          EXTENDED
LD         expr ',' expr                        DIRECT
LD         expr ',' expr                        EXTENDED

LDB        expr ',' '#' expr
LDB        expr ',' '[' expr ']'
LDB        expr ',' expr '[' expr ']'          DIRECT
LDB        expr ',' expr '[' expr ']'          EXTENDED
LDB        expr ',' expr                        DIRECT
LDB        expr ',' expr                        EXTENDED

LDBSE      expr ',' '#' expr
LDBSE      expr ',' '[' expr ']'
LDBSE      expr ',' expr '[' expr ']'          DIRECT
LDBSE      expr ',' expr '[' expr ']'          EXTENDED
LDBSE      expr ',' expr                        DIRECT
LDBSE      expr ',' expr                        EXTENDED
```

```
Opcode    Syntax                                     Selection Criteria


LDBZE     expr ',' '#' expr
LDBZE     expr ',' '[' expr ']'
LDBZE     expr ',' expr '[' expr ']'              DIRECT
LDBZE     expr ',' expr '[' expr ']'              EXTENDED
LDBZE     expr ',' expr                           DIRECT
LDBZE     expr ',' expr                           EXTENDED

LJMP      expr

MUL       expr ',' '#' expr
MUL       expr ',' '[' expr ']'
MUL       expr ',' expr ',' '#' expr
MUL       expr ',' expr ',' '[' expr ']'
MUL       expr ',' expr ',' expr '[' expr ']'     DIRECT
MUL       expr ',' expr ',' expr '[' expr ']'     EXTENDED
MUL       expr ',' expr ',' expr                  DIRECT
MUL       expr ',' expr ',' expr                  EXTENDED
MUL       expr ',' expr '[' expr ']'              DIRECT
MUL       expr ',' expr '[' expr ']'              EXTENDED
MUL       expr ',' expr                           DIRECT
MUL       expr ',' expr                           EXTENDED

MULB      expr ',' '#' expr
MULB      expr ',' '[' expr ']'
MULB      expr ',' expr ',' '#' expr
MULB      expr ',' expr ',' '[' expr ']'
MULB      expr ',' expr ',' expr '[' expr ']'     DIRECT
MULB      expr ',' expr ',' expr '[' expr ']'     EXTENDED
MULB      expr ',' expr ',' expr                  DIRECT
MULB      expr ',' expr ',' expr                  EXTENDED
MULB      expr ',' expr '[' expr ']'              DIRECT
MULB      expr ',' expr '[' expr ']'              EXTENDED
MULB      expr ',' expr                           DIRECT
MULB      expr ',' expr                           EXTENDED

MULU      expr ',' '#' expr
MULU      expr ',' '[' expr ']'
MULU      expr ',' expr ',' '#' expr
MULU      expr ',' expr ',' '[' expr ']'
MULU      expr ',' expr ',' expr '[' expr ']'     DIRECT
MULU      expr ',' expr ',' expr '[' expr ']'     EXTENDED
MULU      expr ',' expr ',' expr                  DIRECT
MULU      expr ',' expr ',' expr                  EXTENDED
MULU      expr ',' expr '[' expr ']'              DIRECT
MULU      expr ',' expr '[' expr ']'              EXTENDED
MULU      expr ',' expr                           DIRECT
MULU      expr ',' expr                           EXTENDED
```

```
Opcode     Syntax                                   Selection Criteria

MULUB      expr ',' '#' expr
MULUB      expr ',' '[' expr ']'
MULUB      expr ',' expr ',' '#' expr
MULUB      expr ',' expr ',' '[' expr ']'
MULUB      expr ',' expr ',' expr '[' expr ']'   DIRECT
MULUB      expr ',' expr ',' expr '[' expr ']'   EXTENDED
MULUB      expr ',' expr ',' expr                 DIRECT
MULUB      expr ',' expr ',' expr                 EXTENDED
MULUB      expr ',' expr '[' expr ']'             DIRECT
MULUB      expr ',' expr '[' expr ']'             EXTENDED
MULUB      expr ',' expr                          DIRECT
MULUB      expr ',' expr                          EXTENDED

NEG        expr

NEGB       expr

NOP

NORML      expr ',' expr

NOT        expr

NOTB       expr

OR         expr ',' '#' expr
OR         expr ',' '[' expr ']'
OR         expr ',' expr '[' expr ']'            DIRECT
OR         expr ',' expr '[' expr ']'            EXTENDED
OR         expr ',' expr                         DIRECT
OR         expr ',' expr                         EXTENDED

ORB        expr ',' '#' expr
ORB        expr ',' '[' expr ']'
ORB        expr ',' expr '[' expr ']'            DIRECT
ORB        expr ',' expr '[' expr ']'            EXTENDED
ORB        expr ',' expr                         DIRECT
ORB        expr ',' expr                         EXTENDED

POP        '[' expr ']'
POP        expr '[' expr ']'                     DIRECT
POP        expr '[' expr ']'                     EXTENDED
POP        expr                                  DIRECT
POP        expr                                  EXTENDED

POPA                                             CPU196

POPF
```

```
Opcode      Syntax                                      Selection Criteria

PUSH        '#' expr
PUSH        '[' expr ']'
PUSH        expr '[' expr ']'                           DIRECT
PUSH        expr '[' expr ']'                           EXTENDED
PUSH        expr                                        DIRECT
PUSH        expr                                        EXTENDED

PUSHA                                                   CPU196

PUSHF

RET

RST

SCALL       expr

SETC

SHL         expr ',' '#' expr
SHL         expr ',' expr

SHLB        expr ',' '#' expr
SHLB        expr ',' expr

SHLL        expr ',' '#' expr
SHLL        expr ',' expr

SHR         expr ',' '#' expr
SHR         expr ',' expr

SHRA        expr ',' '#' expr
SHRA        expr ',' expr

SHRAB       expr ',' '#' expr
SHRAB       expr ',' expr

SHRAL       expr ',' '#' expr
SHRAL       expr ',' expr

SHRB        expr ',' '#' expr
SHRB        expr ',' expr

SHRL        expr ',' '#' expr
SHRL        expr ',' expr

SJMP        expr

SKIP        expr
```

```
Opcode     Syntax                                    Selection Criteria


ST         expr ',' '[' expr ']'
ST         expr ',' expr '[' expr ']'                DIRECT
ST         expr ',' expr '[' expr ']'                EXTENDED
ST         expr ',' expr                             DIRECT
ST         expr ',' expr                             EXTENDED

STB        expr ',' '[' expr ']'
STB        expr ',' expr '[' expr ']'                DIRECT
STB        expr ',' expr '[' expr ']'                EXTENDED
STB        expr ',' expr                             DIRECT
STB        expr ',' expr                             EXTENDED

SUB        expr ',' '#' expr
SUB        expr ',' '[' expr ']'
SUB        expr ',' expr ',' '#' expr
SUB        expr ',' expr ',' '[' expr ']'
SUB        expr ',' expr ',' expr '[' expr ']'       DIRECT
SUB        expr ',' expr ',' expr '[' expr ']'       EXTENDED
SUB        expr ',' expr ',' expr                     DIRECT
SUB        expr ',' expr ',' expr                     EXTENDED
SUB        expr ',' expr '[' expr ']'                DIRECT
SUB        expr ',' expr '[' expr ']'                EXTENDED
SUB        expr ',' expr                             DIRECT
SUB        expr ',' expr                             EXTENDED

SUBB       expr ',' '#' expr
SUBB       expr ',' '[' expr ']'
SUBB       expr ',' expr ',' '#' expr
SUBB       expr ',' expr ',' '[' expr ']'
SUBB       expr ',' expr ',' expr '[' expr ']'       DIRECT
SUBB       expr ',' expr ',' expr '[' expr ']'       EXTENDED
SUBB       expr ',' expr ',' expr                     DIRECT
SUBB       expr ',' expr ',' expr                     EXTENDED
SUBB       expr ',' expr '[' expr ']'                DIRECT
SUBB       expr ',' expr '[' expr ']'                EXTENDED
SUBB       expr ',' expr                             DIRECT
SUBB       expr ',' expr                             EXTENDED

SUBC       expr ',' '#' expr
SUBC       expr ',' '[' expr ']'
SUBC       expr ',' expr '[' expr ']'                DIRECT
SUBC       expr ',' expr '[' expr ']'                EXTENDED
SUBC       expr ',' expr                             DIRECT
SUBC       expr ',' expr                             EXTENDED

SUBCB      expr ',' '#' expr
SUBCB      expr ',' '[' expr ']'
SUBCB      expr ',' expr '[' expr ']'                DIRECT
```

```
Opcode    Syntax                                   Selection Criteria

SUBCB     expr ',' expr '[' expr ']'               EXTENDED
SUBCB     expr ',' expr                            DIRECT
SUBCB     expr ',' expr                            EXTENDED

XOR       expr ',' '#' expr
XOR       expr ',' '[' expr ']'
XOR       expr ',' expr '[' expr ']'               DIRECT
XOR       expr ',' expr '[' expr ']'               EXTENDED
XOR       expr ',' expr                            DIRECT
XOR       expr ',' expr                            EXTENDED

XORB      expr ',' '#' expr
XORB      expr ',' '[' expr ']'
XORB      expr ',' expr '[' expr ']'               DIRECT
XORB      expr ',' expr '[' expr ']'               EXTENDED
XORB      expr ',' expr                            DIRECT
XORB      expr ',' expr                            EXTENDED
```

A.2.2 *Selection_Criteria_Keywords*

DIRECT   The instruction will be generated
                  with a short form if the last
                  operand will fit in one byte, and
                  is defined when the instruction is
                  processed in the first pass.

EXTENDED   The instruction can be generated
                  with a long form.

CPU196   The instruction is implemented only
                  in the 80c196.

A.2.3 *Apostrophes*   The apostrophes in the syntax field are
a notation used for the parser generator and are not put in
the assembler source statement.

A.3 **Notes**

A.3.1 *Data_Alignment*   In the second pass, data address are
checked for alignment. If the operand field is not
divisible by 2 for word references, or by 4 for long word
references, the error message "expression fails validity
test" occurs.

A.3.2 *Generic_Jumps*   The assembler requires that the length
of an instruction be able to be determined at the first
pass, so generalized generic jumps could not be implemented.

A.3.3 *Reserved_Symbols*

A.3.3.1 *Standard_Reserved_Symbols* AND DEFINED EQ GE GT
HIGH LE LOW LT MOD NE NOT OR SHL SHR XOR and defined eq ge
gt high le low lt mod ne not or shl shr xor

CONTENTS