as6502.doc

A. Appendix for as6502 Frankenstein Assembler

1. Pseudo Operations

a) 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" RESERVE RMB
- "Define Byte Data" BYTE DB FCB
- "Define Word Data" DW FDB WORD
- "Define String Data" FCC STRING
- "Define Character Set Translation" CHARSET
- "Define Character Value" CHARDEF CHD
- "Use Character Translation" CHARUSE
```

b) Machine Dependent Pseudo Operations

• Define Word Data

```
The define word pseudo-operations generates the byte reversed (low byte, high
byte) representation.
```

• 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 argument, 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
- "ROCKWELL CMOS" R65C r65c
- "CMOS" 65C 65c
- "ROCKWELL Extended" R65 r65
- "R65C00/21" 21
- "Standard NMOS" 65
```

2. Instructions

a) Instruction List

```
;
l l l.
Opcode      Syntax       Selection Criteria
ADC    '#' topexpr
ADC    '(' topexpr ')' ',' INDEX    DIRECT INDEXY
ADC    '(' topexpr ')'  DIRECT INSTCMOS
ADC    '(' topexpr ',' INDEX ')'    DIRECT INDEXX
ADC    topexpr ',' INDEX      DIRECT INDEXX
ADC    topexpr ',' INDEX      EXTENDED INDEXX
ADC    topexpr ',' INDEX      INDEXY
ADC    topexpr    DIRECT
```

```
ADC     topexpr     EXTENDED
AND     '#' topexpr
AND     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
AND     '(' topexpr ')'  DIRECT INSTCMOS
AND     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
AND     topexpr ',' INDEX    DIRECT INDEXX
AND     topexpr ',' INDEX    EXTENDED INDEXX
AND     topexpr ',' INDEX    INDEXY
AND     topexpr     DIRECT
AND     topexpr     EXTENDED
ASL     ACCUM
ASL     topexpr ',' INDEX    DIRECT INDEXX
ASL     topexpr ',' INDEX    EXTENDED INDEXX
ASL     topexpr     DIRECT
ASL     topexpr     EXTENDED
BBR0    topexpr ',' topexpr    INSTROCKWELL
BBR1    topexpr ',' topexpr    INSTROCKWELL
BBR2    topexpr ',' topexpr    INSTROCKWELL
BBR3    topexpr ',' topexpr    INSTROCKWELL
BBR4    topexpr ',' topexpr    INSTROCKWELL
BBR5    topexpr ',' topexpr    INSTROCKWELL
BBR6    topexpr ',' topexpr    INSTROCKWELL
BBR7    topexpr ',' topexpr    INSTROCKWELL
BBS0    topexpr ',' topexpr    INSTROCKWELL
BBS1    topexpr ',' topexpr    INSTROCKWELL
BBS2    topexpr ',' topexpr    INSTROCKWELL
BBS3    topexpr ',' topexpr    INSTROCKWELL
BBS4    topexpr ',' topexpr    INSTROCKWELL
BBS5    topexpr ',' topexpr    INSTROCKWELL
BBS6    topexpr ',' topexpr    INSTROCKWELL
BBS7    topexpr ',' topexpr    INSTROCKWELL
BCC     topexpr
BCS     topexpr
BEQ     topexpr
BGE     topexpr
BIT     '#' topexpr       INSTCMOS
BIT     topexpr ',' INDEX    DIRECT INDEXX INSTCMOS
BIT     topexpr ',' INDEX    EXTENDED INDEXX INSTCMOS
BIT     topexpr     DIRECT
BIT     topexpr     EXTENDED
BLT     topexpr
BMI     topexpr
BNE     topexpr
BPL     topexpr
BRA     topexpr     INST21
BRA     topexpr     INSTCMOS
BRK     '#' topexpr
BRK
BVC     topexpr
BVS     topexpr
CLC
CLD
CLI
CLV
CMP     '#' topexpr
CMP     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
CMP     '(' topexpr ')'  DIRECT INSTCMOS
CMP     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
CMP     topexpr ',' INDEX    DIRECT INDEXX
CMP     topexpr ',' INDEX    EXTENDED INDEXX
CMP     topexpr ',' INDEX    INDEXY
```

```
CMP     topexpr     DIRECT
CMP     topexpr     EXTENDED
CPX     '#' topexpr
CPX     topexpr     DIRECT
CPX     topexpr     EXTENDED
CPY     '#' topexpr
CPY     topexpr     DIRECT
CPY     topexpr     EXTENDED
DEC     ACCUM       INSTCMOS
DEC     topexpr ',' INDEX       DIRECT INDEXX
DEC     topexpr ',' INDEX       EXTENDED INDEXX
DEC     topexpr     DIRECT
DEC     topexpr     EXTENDED
DEX
DEY
EOR     '#' topexpr
EOR     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
EOR     '(' topexpr ')'  DIRECT INSTCMOS
EOR     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
EOR     topexpr ',' INDEX       DIRECT INDEXX
EOR     topexpr ',' INDEX       EXTENDED INDEXX
EOR     topexpr ',' INDEX       INDEXY
EOR     topexpr     DIRECT
EOR     topexpr     EXTENDED
INC     ACCUM       INSTCMOS
INC     topexpr ',' INDEX       DIRECT INDEXX
INC     topexpr ',' INDEX       EXTENDED INDEXX
INC     topexpr     DIRECT
INC     topexpr     EXTENDED
INX
INY
JMP     '(' topexpr ')'
JMP     '(' topexpr ',' INDEX ')'    INSTCMOS INDEXX
JMP     topexpr
JSR     topexpr
LDA     '#' topexpr
LDA     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
LDA     '(' topexpr ')'  DIRECT INSTCMOS
LDA     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
LDA     topexpr ',' INDEX       DIRECT INDEXX
LDA     topexpr ',' INDEX       EXTENDED INDEXX
LDA     topexpr ',' INDEX       INDEXY
LDA     topexpr     DIRECT
LDA     topexpr     EXTENDED
LDX     '#' topexpr
LDX     topexpr ',' INDEX       DIRECT INDEXY
LDX     topexpr ',' INDEX       EXTENDED INDEXY
LDX     topexpr     DIRECT
LDX     topexpr     EXTENDED
LDY     '#' topexpr
LDY     topexpr ',' INDEX       DIRECT INDEXX
LDY     topexpr ',' INDEX       EXTENDED INDEXX
LDY     topexpr     DIRECT
LDY     topexpr     EXTENDED
LSR     ACCUM
LSR     topexpr ',' INDEX       DIRECT INDEXX
LSR     topexpr ',' INDEX       EXTENDED INDEXX
LSR     topexpr     DIRECT
LSR     topexpr     EXTENDED
MUL         INST21
NOP
```

```
ORA     '#' topexpr
ORA     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
ORA     '(' topexpr ')'  DIRECT INSTCMOS
ORA     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
ORA     topexpr ',' INDEX    DIRECT INDEXX
ORA     topexpr ',' INDEX    EXTENDED INDEXX
ORA     topexpr ',' INDEX    INDEXY
ORA     topexpr    DIRECT
ORA     topexpr    EXTENDED
PHA
PHP
PHX         INST21
PHX         INSTCMOS
PHY         INST21
PHY         INSTCMOS
PLA
PLP
PLX         INST21
PLX         INSTCMOS
PLY         INST21
PLY         INSTCMOS
RMB0    topexpr    INSTROCKWELL
RMB1    topexpr    INSTROCKWELL
RMB2    topexpr    INSTROCKWELL
RMB3    topexpr    INSTROCKWELL
RMB4    topexpr    INSTROCKWELL
RMB5    topexpr    INSTROCKWELL
RMB6    topexpr    INSTROCKWELL
RMB7    topexpr    INSTROCKWELL
ROL     ACCUM
ROL     topexpr ',' INDEX    DIRECT INDEXX
ROL     topexpr ',' INDEX    EXTENDED INDEXX
ROL     topexpr    DIRECT
ROL     topexpr    EXTENDED
ROR     ACCUM
ROR     topexpr ',' INDEX    DIRECT INDEXX
ROR     topexpr ',' INDEX    EXTENDED INDEXX
ROR     topexpr    DIRECT
ROR     topexpr    EXTENDED
RTI
RTS
SBC     '#' topexpr
SBC     '(' topexpr ')' ',' INDEX    DIRECT INDEXY
SBC     '(' topexpr ')'  DIRECT INSTCMOS
SBC     '(' topexpr ',' INDEX ')'    DIRECT INDEXX
SBC     topexpr ',' INDEX    DIRECT INDEXX
SBC     topexpr ',' INDEX    EXTENDED INDEXX
SBC     topexpr ',' INDEX    INDEXY
SBC     topexpr    DIRECT
SBC     topexpr    EXTENDED
SEC
SED
SEI
SMB0    topexpr    INSTROCKWELL
SMB1    topexpr    INSTROCKWELL
SMB2    topexpr    INSTROCKWELL
SMB3    topexpr    INSTROCKWELL
SMB4    topexpr    INSTROCKWELL
SMB5    topexpr    INSTROCKWELL
SMB6    topexpr    INSTROCKWELL
SMB7    topexpr    INSTROCKWELL
```

```
STA    '(' topexpr ')' ',' INDEX    DIRECT INDEXY
STA    '(' topexpr ')'  DIRECT INSTCMOS
STA    '(' topexpr ',' INDEX ')'    DIRECT INDEXX
STA    topexpr ',' INDEX    DIRECT INDEXX
STA    topexpr ',' INDEX    EXTENDED INDEXX
STA    topexpr ',' INDEX    INDEXY
STA    topexpr    DIRECT
STA    topexpr    EXTENDED
STX    topexpr ',' INDEX    DIRECT INDEXY
STX    topexpr    DIRECT
STX    topexpr    EXTENDED
STY    topexpr ',' INDEX    DIRECT INDEXX
STY    topexpr    DIRECT
STY    topexpr    EXTENDED
STZ    topexpr ',' INDEX    DIRECT INDEXX INSTCMOS
STZ    topexpr ',' INDEX    EXTENDED INDEXX INSTCMOS
STZ    topexpr    DIRECT INSTCMOS
STZ    topexpr    EXTENDED INSTCMOS
TAX
TAY
TRB    topexpr    DIRECT INSTCMOS
TRB    topexpr    EXTENDED INSTCMOS
TSB    topexpr    DIRECT INSTCMOS
TSB    topexpr    EXTENDED INSTCMOS
TSX
TXA
TXS
TYA
```

b) Operands

- ACCUM The a or (A) reserved symbol
- INDEX The x or y (or X or Y) reserved symbols

c) Selection Criteria Keywords

- DIRECT The instruction can use the direct addressing mode. The expression
must have a value between 0 and 255 that is defined when the instruction is
processed in the input pass.
- EXTENDED The instruction can use the extended (16 bit address) mode.
- INDEXX The instruction can use the X index.
- INDEXY The instruction can use the Y index.
- INSTCMOS The instruction is in the CMOS and ROCKWELL CMOS instruction sets.
- INSTROCKWELL The instruction is in the ROCKWELL, ROCKWELL CMOS, and R65c00/21
instruction sets.
- INST21 The instruction is in the R65c00/21 instruction set.

d) Apostrophes

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

3. Notes

a) Top Expressions

The syntax of some of the instructions combined with the standard expression
syntax resulted in confusion whether an operand was an expression surrounded by
parenthesis, or a indexed reference.
To get around this, the expressions in these ambiguous cases were restricted to
those forms of expression that don't have surrounding parenthesis at the top
level.
Subexpressions may be parenthesized, but only if an operator separates or
precedes the subexpression.
Example
```
lda 47h,y         ; load absolute, y
```

```
lda +(47h),y      ; load absolute, y
lda (47h),y       ; load (indirect), y
lda ((47h)),y     ; error
```

b) Reserved Symbols

- <u>Machine Dependent Reserved Symbols</u>

```
A
X
Y
a
x
y
```

- <u>Standard Reserved Symbols</u>

```
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
```