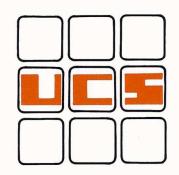
MOS TECHNOLOGY, INC.

## **AICROCOAPUTERS**

# MCS6500 **MICROPROCESSOR** SOFTWARE **SUPPORT**



MOS TECHNOLOGY'S support software is now available on United Computing Systems time-sharing service. The package available provides online support to assist the microcomputer applications design engineer or programmer in program development for the MCS650X microcomputer family.

TO USE MOS TECHNOLOGY SUPPORT SOFT-

- Contact your local USC sales representative and request MOS TECHNOLOGY'S MCS650X Software System under user catalog number M490. Also request the UCS System Guide and the UNIEDIT manuals.
   Order your copy of the MCS6500 Microprocessor Hardware, Programming, Simulator, And Cross Assembler manuals from:
   MOS Technology Inc., 950 Rittenhouse Rd., Norristown, Pa. 19401
   Dial the appropriate telephone number sup-
- Norristown, Pa. 19401
  Dial the appropriate telephone number supplied by your USC sales representative, sign on with your terminal, and begin entering your MCS650X microprocessor program.

THE SOFTWARE SUPPORT PACKAGE CONSISTS

- A text file containing the latest bulletins regarding MOS TECHNOLOGY Micro--MOS/\*\*\* processor Software.
- -ASM/\*\*\* An interactive program which builds the job control language required to submit your source code to ASM650X.
- MCS650X Cross Assembler: the Cross Assembler is a program which translates a mnemonic or symbolic form of a com-puter program to machine language. ASM650X
- An interactive program which builds the job control language required to submit your simulator command file to -SIM/\*\*\* -SIM650X.

SIM650X - MCS650X Simulator. The simulator uses the command file to simulate execution of the machine language instructions created by the cross assembler in the MCS650X microprocessor.

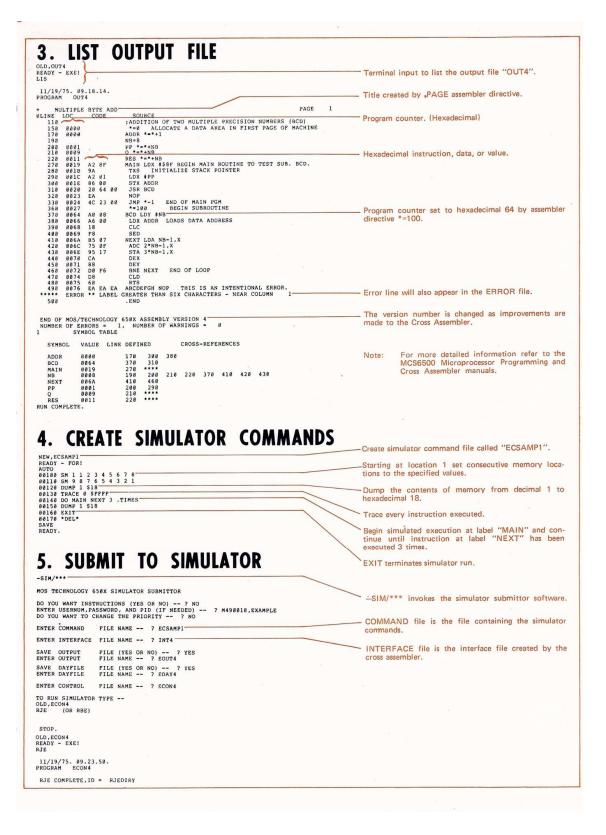
-DMP/\*\*\* - ROM dump program. This program creates an output file of machine language instructions in a format suitable for MOS microcomputer loader programs.

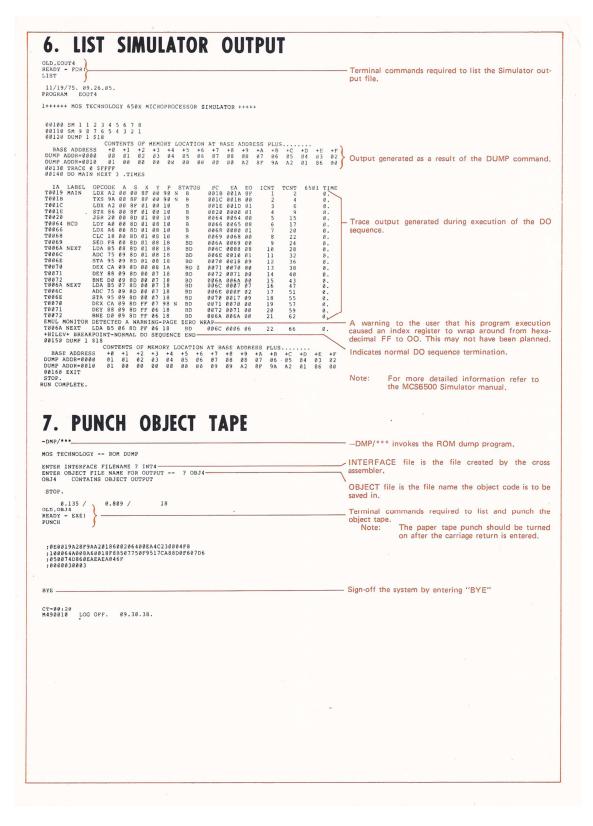
The sample program shown in this brochure uses the UCS time-sharing system to give the user an overview of the procedure to be followed for using MOS TECH-NOLOGY'S support software.

In brief the procedure to be followed is:

- 1. Create a source file using the time-sharing editor and save the file.
- 2. Submit the source file to the Cross Assembler by answering the questions asked by -ASM/\*\*\*.
- 3. When the Cross Assembler run is completed list the output file to obtain a listing of the assembled program.
- 4. Create a file of simulator commands using the time-sharing editor and save the file.
- 5. Submit the simulator command file and the machine language file to the simulator by answering the questions asked by -SIM/\*\*\*.
- When the simulator run is completed list the output file to obtain the results of the program simulation.
- Obtain a ROM dump object tape by answering the questions asked by -DMP/\*\*\*.

```
1. CREATE A SOURCE FILE.
                                                                                                                    Enter proper response so that computer can determine
                                                                                                                    your terminal's speed.
 UCS 11/19/75. 09.10.41. I15
USER NUMBER: M490010, EXAMPLE
                                                                                                                            For 10 CPS enter
For 15 CPS enter
For 30 CPS enter
                                                                                                                                                           T63
  MESSAGE(S) COMPLETE.
                                                                                                                    Enter your user number and password to log on to
 0.013 / 0.038 /
READY - FOR!
                                                                                                                    UCS system.
                                                                                                                    Indicates FORTRAN system is ready. (FORTRAN is
                                                                                                                    automatically assigned.)
 11/19/75. 09.11.22.
PROGRAM MOS
                                                                                                                    Enter -MOS/*** to obtain latest bulletins.
 LAST UPDATED ON 11/19/75
 .
BULLETINS REGARDING THE MOS TECHNOLOGY MICROPROCESSOR
SOFTWARE WILL APPEAR FROM TIME TO TIME IN THIS MANNER.
 . TO RUN THE 650X CROSS ASSEMBLER YOU MUST FIRST CREATE A SOURCE FILE. THEN ENTER -ASM/*** TO SUBMIT YOUR SOURCE FILE FOR BACKGROUND BATCH EXECUTION.
                                                                                                                    Indicates the end of the bulletin.
 . TO RUN THE 650% SIMULATOR YOU MUST FIRST CREATE A SIMULATOR COMMAND FILE AND A CROSS ASSEMBLER INTERFACE FILE. THEN TYPE --SIM/*** TO SUBMIT YOUR COMMAND FILE FOR SIMULATION.
                                                                                                                    Create a new file with file name "SAMP4".
 . THE 658X ROM DUMP PROGRAM WILL CREATE A REFORMATED FILE SUITABLE FOR INPUT TO THE MOS MICCROCOMPUTER LOADER PROGRAMS. YOU MUST HAVE CREATED AN INTERFACE FILE WITH THE CROSS ASSEMBLER. TO RUN THE DUMP PROGRAM ENTER -DMP658X/***
                                                                                                                    Assembler directive to advance listing to top of page and title the page "MULTIPLE BYTE ADD".
Semicolon indicates the start of a comment field.
                                                                                                                    *= assembler directive sets the program counter.
                                                                                                                    Sets NB equal to 8.
                                                                                                                  Reserves 8 bytes of memory for the label "PP".
                                                                                                                    Start of program labeled "MAIN"
                                                                                                                          Note that there is only one space between a line
                                                                                                                          number and a label. There are two or more spaces between a line number and an instruction. Comments may begin one space after the operand.
                                                                                                                    .END assembler directive defines the end of the source
                                                                                                                    program.
           BNE NEXT END OF LOOP
                                                                                                                    Hitting the "ESC" key ends the auto line number assignment. The system replies "*DEL*".
 00470 CLD
00480 RTS
00490 ABCDEFGH NOP THIS IS AN INTENTIONAL ERROR.
                                                                                                                    SAVE is the command to save the new file just creat-
 2. SUBMIT TO CROSS ASSEMBLER.
 -ASM/***
 MOS TECHNOLOGY 650X CROSS ASSEMBLER SUBMITTOR
                                                                                                                      -ASM/*** invokes the cross assembler submittor
 DO YOU WANT INSTRUCTIONS (YES OR NO) -- ? NO ENTER USERNUM, PASSWORD, AND PID (IF NEEDED) -- ? M498018, EXAMPLE DO YOU WANT TO CHANGE THE PRIORITY -- ? NO
                                                                                                                     software.
                                                                                                                     SOURCE file is the file containing the source code to
 ENTER SOURCE FILE NAME -- ? SAMP4 --
 SAVE OUTPUT FILE (YES OR NO) -- ? YES ENTER OUTPUT FILE NAME -- ? OUT4
                                                                                                                    OUTPUT file will contain the assembler listing.
                                                                                                                    INTERFACE file will contain the object code, line number and label information required by the sim-
 SAVE INTERFACE FILE (YES OR NO) -- ? YES ENTER INTERFACE FILE NAME -- ? INT4
                                                                                                                    ulator.
 SAVE ERROR FILE (YES OR NO) -- ? YES ENTER ERROR FILE NAME -- ? ERR4
                                                                                                                    ERROR file will contain a listing of any errors that occur during the assembly.
 SAVE DAYFILE FILE (YES OR NO) -- ? YES ENTER DAYFILE FILE NAME -- ? DAY4
 ENTER CONTROL FILE NAME -- ? CON4.
                                                                                                                    DAY file is a history of steps taken by the UCS system in running your job.
 TO RUN ASSEMBLER TYPE --
 OLD, CON4
RJE (OR RBE)
                                                                                                                    CONTROL file is the file of JCL built by -ASM/*** to run your assembly.
 STOP.
OLD,CON4
READY - EXE!_
RJE
                                                                                                                    Submits assembly job to the UCS system.
                                                                                                                    Indicates that the job has been submitted under the job name "RJEDZQM".
  11/19/75. 09.15.45.
PROGRAM CON4
  RJE COMPLETE.ID = RJEDZOM.
```





## MCS6500 **MICROPROCESSOR** LANGUAGE

## INSTRUCTION SET

ADC	Add Memory to Accumulator with Carry
AND	"AND" Memory with Accumulator
ASL	Shift Left One Bit (Memory or Accumulator
BCC	Branch on Carry Clear
200	D

BCC Branch on Carry Clear
BCS Branch on Carry Set
BEG Branch on Result Zero
BIT Test Bits in Memory with Accumulator
BMI Branch on Result Plans
BMI Branch on Result Memory
BMI Branch on Result Minus
BMI Branch on Overflow Gear
CLI Clear Carry Flag
CMP Compare Memory and Accumulator
CMP Compare Memory and Accumulator
CMP Compare Memory and Accumulator
DEC Decrement Memory by One
DEV Decrement Index X by One
DEV Decrement Index X by One
DEV Decrement Memory by One
INV Increment X by One
INV Increm

NOP No Operation
ORA "OR" Memory with Accumulate
PHA Push Accumulator on Stack
PHP Push Processor Status on Stack
PLA Pull Accumulator from Stack
PLP Pull Processor Status from Stack
ROL Rotate One Bit Left (Memory or

RTI Beturn From Interrupt
RTS Resum From Subroutine
SBG Subtract Memory from Accumulator with Borrow
SEC Set Carry Flag
SED Set Decimal Mode
SEI Set Carry Flag
SEI Set Interrupt Disability Status
STA Store Accumulator in Memory
STX Store Index X in Memory
STX Store Index X in Memory
TAX Traveler Accumulator to Index X
TAX Traveler Accumulator to Index X
TXA Traveler Accumulator to Index X
TXA Traveler Index X to Stack Pointer to Index X
TXA Traveler Index X to Stack Pointer TYA

EXECUTION TIMES (IN CLOCK CYCLES)

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## ADDRESSING MODES

ACCUMULATOR ADDRESSING
This form of addressing is represented with a one byte
instruction, implying an operation on the accumulator.

IMMEDIATE ADDRESSING
In immediate addressing, the operand is contained in the
second byte of the instruction, with no further memory
addressing required.

### ABSOLUTE ADDRESSING

ABSOLUTE ADDRESSING
In absolute addressing, the second byte of the instruction specifies the eight low order bits of the effective addressing while the third byte specifies the eight high order bits. Thus, the absolute addressing mode allows access to the entire 65K bytes of addressable memory.

ZERO PAGE ADDRESSING
The zero page instructions allow for shorter code and execution times by only fetching the second byte of the instruction and assuming a zero high address byte. Careful use of the zero page can result in significant increase in code efficiency.

code efficiency.

INDEXED ZERO PAGE ADDRESSING — (X, Y indexing) NDEXED ZERO PAGE ADDRESSING — (X, Y indexing) This form of addressing is used in conjunction with the index register and is referred to as "Zero Page, X" or "Zero Page, Y". The effective address is calculated by adding the second byte to the contents of the index register. Since this is a form of "Zero Page" addressing, the content of the second byte references a location in page zero. Additionally due to the "Zero Page" addressing nature of this mode, no carry is added to the high order 8 bits of memory and crossing of page boundaries does not occur. occur.

INDEXED ABSOLUTE ADDRESSING – (X, Y, indexing)

of addressing is used in conjunction with X and

NDEXED ABSULUTE ADDRESSING — (A. Y., indexing)
This form of addressing is used in conjunction with X and Y index register and is referred to as "Absolute, X", and "Absolute, Y". The effective address is formed by adding the contents of X or Y to the address contained in the second and third bytes of the instruction. This mode allows the index register to contain the index depending and the instruction to contain the base dress. This type of indexing allows any location referencing and the index to modify multiple fields resulting in reduced coding

### IMPLIED ADDRESSING

In the implied addressing mode the address containing the operand is implicitly stated in the operation code of the

### RELATIVE ADDRESSING

Relative addressing is used only with branch instructions and establishes a destination for the conditional branch.

and establishes a destination for the conditions of the operand which is an "Offset" added to the contents of the lower eight bits of the program counter when the counter is set at the next instruction. The range of the offset is -128 to +127 bytes from the next instruction.

at the next instruction. The range of the offset is -128 to +127 bytes from the next instruction.

INDEXED INDIRECT ADDRESSINO

In indexed indirect addressing freferred to as (Indirect, XI), the second byte of the instruction is added to the contents of the X index register, discarding the carry. The result of this addition points to a memory location on page zero whose contents is the low order eight bits of the effective address. The next memory location eight bits of the effective address preciving the high cities address. The precipitation of the properties of the effective address must be in page zero.

INDIRECT INDEXEM ADDRESSINO

In indirect indexed addressing freferred to as (Indirect), the second byte of the instruction points to a memory location in page zero. The contents of this memory location is added to the contents of the Y index register, the result being the low order eight bits of the effective address. The carry from this addition is added to the contents of the result being the high order eight bits of the effective address. The carry from this addition is added to the contents of the next page zero memory location, the result being the high order eight bits of the effective address. The carry from this addition is added to the contents of the next page zero memory location, the result being the high order eight bits of the effective address.

BSOLUTE INDIRECT
The second byte of the instruction contains the low order eight bits of a memory location. The high order eight bits of that memory location is contained in the third byte of the instruction. The contents of the fully specified memory location is the low order byte of the effective address. The next memory location contains the high order byte of the effective address which is loaded into the sixteen bits of the program counter.

ASSEMBLER DIRECTIVES
"OPT — If used must be the first executable statement in the program.

•OPTIONS ARE: — (Options listed are the default value.) COUNT (COU or CNT)

NOGENERATE (NOG)

List all instructions and their usage.

Do not generate more than one line of code for ASCII

XREF (XRE)

strings. Produce a cross-reference list

ERRORS (ERR)

in the symbol table. Create an error file

MEMORY (MEM)

Create an assembler object output file.
 Produce a full assembly listing.

LIST (LIS)

•BYTE — Produces a single BYTE in memory equal to each operand specified.

•WORD - Produces two BYTES in memory equal to each operand specified.
\*= - Defines the beginning of a new program counter

sequence.  ${}_{\bullet}\mathsf{PAGE}-\mathsf{Advances}$  the listing to the top of a new page.

•END – Defines the end of a source program.

Labels begin in column 1 and are separated from the instruction by at least one space.

Labels can be up to 6 alphanumenic characters long and must begin with an alpha character.

A, X, Y, S, and P are reserved and cannot be used as labels.

 $\ensuremath{\mathsf{LABEL}}\xspace = \ensuremath{\mathsf{Expression}}\xspace$  can be used to equate labels to instructions.

LABEL \* = \* + N can be used to reserve areas in memory. CHARACTERS USED AS SPECIAL PREFIXES:

- Indicates an assembler directive.
  # Specifies the immediate mode of addressing.
  Specifies a hexadecimal character.
  Specifies an octal number.
  Specifies an inary number.
  Specifies an ASCII literal character.
  In column 1 indicates a comment

- In column 1 indicates a comment.

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