Introduction to MACRO II

This memorandum is intended for the programmer just starting to use the TX-0 computer. It explains how to use the MACRO II compiler program to assemble a program that is punched in "English" on flexowriter tape and to convert this program to a binary tape program that can be read directly into the TX-0. There are many additional features of MACRO II, which are described in M5001-5, that are not discussed in this memorandum.

The programmer may specify the absolute location of any word or instruction or a constant by typing the absolute location, then a bar, and then the word. The first instruction of a program is automatically stored in register 20_8, unless the programmer specifies another location. After the location of a word is fixed, all the following words are stored in successive registers until the absolute location of another word is assigned by means of the vertical bar. A symbolic address is defined by following the symbol with a comma. When a symbolic address is used with a word, the symbolic address is set equal to the absolute location of that word. The address part of an addressable command may be a symbolic location. (The illustrative example on page 5 should help one to understand this double-talk.)

Constants are automatically stored by MACRO II when parentheses are placed around the constant quantity to be stored. MACRO II replaces the parenthetical term with the absolute location of the register that will contain this constant. Constant quantities may be combinations of instructions, octal numbers, and symbolic addresses separated by + and - signs.

The absolute location of an instruction may be denoted by a period when this location is referred to in the address part of the instruction. See the example for an illustration of this feature of MACRO II. Instruction addresses may be combinations of period, symbolic addresses, and octal numbers separated by + and - signs.

The format of the source program for a MACRO II conversion is as follows. Type at least six inches of tape feed, then the program title followed by a carriage return. Type all absolute address and symbolic address terms from the left-hand margin after striking the color change key. Absolute addresses are followed by a bar, symbolic addresses by a comma. Type all commands indented from the left margin by hitting the tabulator key; color change is not necessary here. Do not type spaces at all except

in the program title, between "start" and the starting location, and between the instruction and address of an addressable command. A symbolic address may be any group of one, two, or three characters, at least one being a letter, except for those combinations which represent instructions understood by MACRO II [See Appendix I to M5001-13.] After the last word of the program, type a carriage return, a color change, and the word "constants". All the constants demanded by the program will be stored in a block following the location of the last word typed. After constants, type a carriage return, an inch or so of tape feed, the word "start", a space, and the location at which the program is to be entered. Then type a carriage return and a few inches of tape feed. This completes the program.

MACRO II will ignore the delete punches used in correcting mispunched tape; but MACRO II will complain at the sight of a backspace. Type your program in lower case characters.

The example program was typed with extra spaces between the lines in order that the comments might be typed. These extra spaces are ignored by MACRO II, and are, therefore, unnecessary.

Important points frequently forgotten:

Always tape feed before beginning typing.
Always have the "7th code" button depressed.
Always reserve registers for temporary and variable storage locations used by your program.
Always follow the "start" designation by a carriage return.

Example

DEMONSTRATION PROGRAM

```
    1000|
beg.    cla             The first instruction cla is stored in register 1000(8). The symbolic address "beg" is assigned the value 1000(8). If "1000|" had not been typed cla would have been stored in register 20(8).
        sto zed
        add set
        add (add-1)     The constant add-1 = 177777(8) is automatically stored in some register x and and register 1003 contains add x.
        sto ret+5       This instruction is stored as sto 1012.
ret.    cla
        add .+4         This instruction is stored as add 1012.
        add (1)
        sto .+2         Stored as sto 1012 in register 1010.
        cla
        0               This register at location 1012 will be filled by the action of the program. However, something must be typed here to reserve the register for this purpose.
        add zed         Incidentally, this instruction could have been written as "201022".
        sto zed
        cla
        add -4          Stored as add 1012 in register 1016.
        add (-add-tab-17+1)  The constant "-add-tab-17+1" = -(200000 + 2000+17+1) = -202016 = 575761 is stored in some register y and register 1017 contains add y.
        trn ret
        hlt
zed.    0               The symbolic address "zed" is defined as 1022. If "0" had not been typed here MACRO would not reserve a register and "set" would also be defined as 1022.
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set, tab	"set" is defined as 1023. This register will contain the value of the symbol "tab" or 2000.
2000! tab,	The symbolic address "tab" is assigned the value 2000. This typing by itself will not cause anything to be stored.
tab+17!	The block of 17 registers from 2000 through 2016 are reserved for a table. These registers will not be affected when the binary tape is read into the machine.
constants	The three constants used in this program, namely add-1, 1, and -add-tab-17+1, will be stored in registers 2017, 2020, and 2021, respectively.
start 1000	The first instruction to be performed is in register 1000. Typing "start beg" would have the same effect.