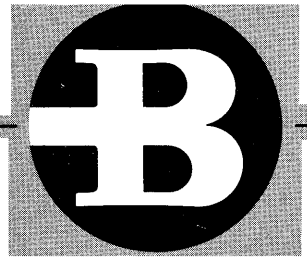


Burroughs L/TC

BASIC ASSEMBLER

REFERENCE MANUAL

Burroughs

L/TC
BASIC ASSEMBLER

REFERENCE MANUAL

$5.00

Burroughs Corporation

Detroit, Michigan 48232

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

INTRODUCTION

This manual will provide the information necessary for the L/TC user to write and assemble symbolic programs using the GP 300 Basic Language. In Section 1 the coding form is analyzed by column. It is suggested that the reader remove the coding form sample on page xiv and locate each specific area on the form as he reads the text. In Section 2 each of the GP 300 series firmware instructions is presented. Individual instructions are discussed in a narrative section followed by an example which illustrates the capabilities of the instruction. The instructions (Op Codes) are presented alphabetically by a category which relates to machine function.

Section 3 defines the rules and techniques used in symbolic program writing and debugging. To the non-experienced user it is suggested that he read pages 3-1–3-2 of Section 3 before attempting the other materials contained in this manual.

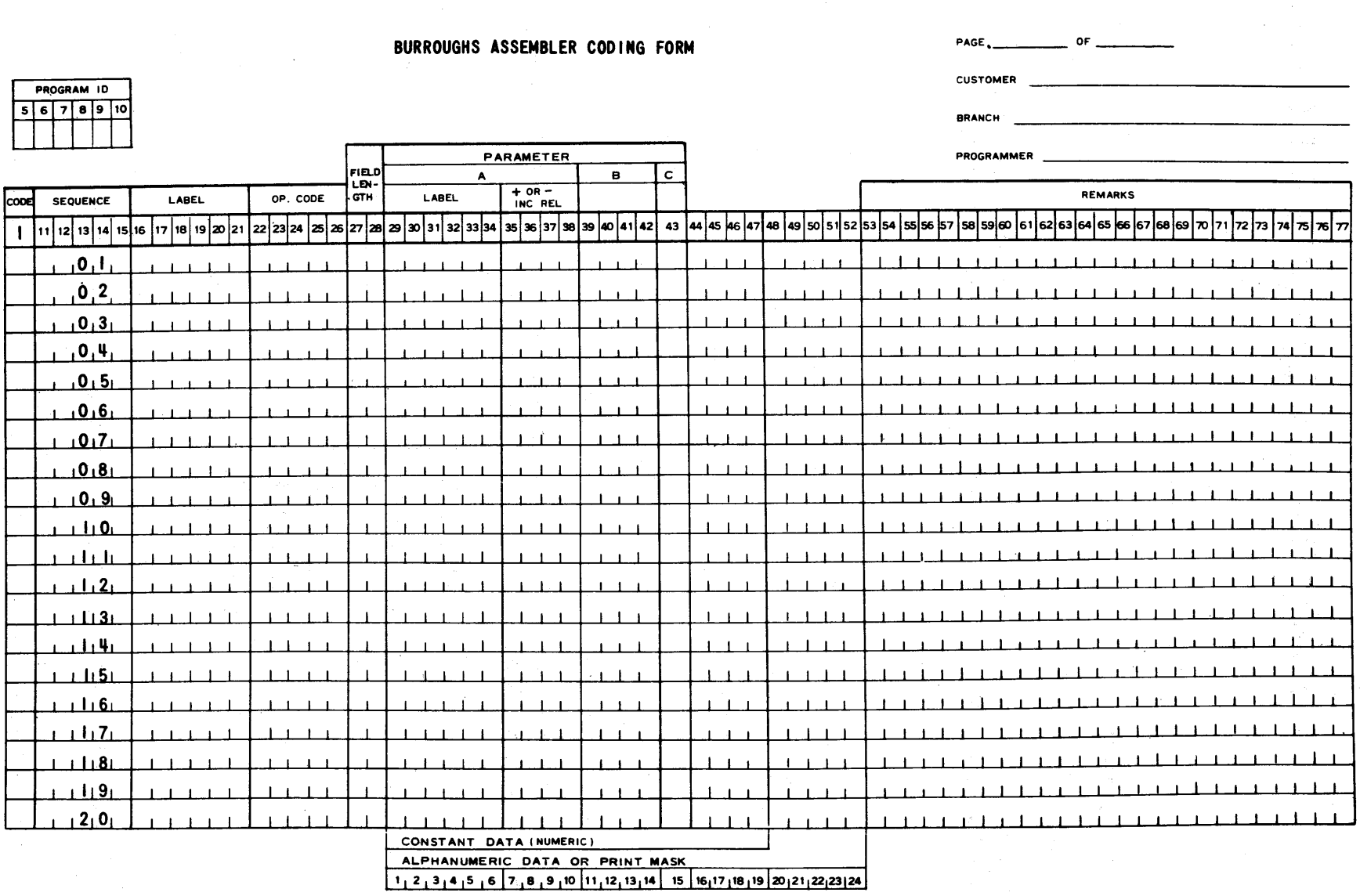
A typical billing problem is discussed in Section 4. The analysis begins with the program definition and carries through to the sample output on an invoice. Section 5 is a functional description of the Basic Assemblers. Operating instructions are included.

The methods of object program loading are discussed in Section 6.

Users are provided a means of quickly referencing selected areas of the manual by coded boxes placed in the upper corner of key pages. The information contained within the box is indicative of the material on that page. In Section 2 the symbolic OP code is placed in these boxes along with a symbol to indicate the type of firmware set to which the instruction applies. These are: CD–check digit add-on firmware sets, CRD-80–column card firmware sets, DC–data communications firmware sets, and PT–paper tape firmware sets.

Boxes which do not contain a firmware code apply to the basic instructions which are generally common to all firmware sets.

The information provided in this manual applies to the 32-track styles of the Series L/TC. The modifications necessary to utilize this manual for the 40-track styles of the Series L are provided in Appendix K.



BURROUGHS ASSEMBLER CODING FORM

PAGE _____ OF _____

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	01								
	02								
	03								
	04								
	05								
	06								
	07								
	08								
	09								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

Burroughs Assembler Coding Form

SECTION 1

ASSEMBLER CODING FORM

PROGRAM ID					
5	6	7	8	9	10

PROGRAM IDENTIFICATION

DEFINITION – Identifies a specific program.

FIELD DEFINITION – One through six alphanumeric characters entered in columns 5-10. Right or left justified. Automatically reproduced on succeeding cards with punched card source program.

PAGE _____ OF _____

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PAGE NUMBER AND HEADING

DEFINITION – Identifies and sequentially locates coded pages of a program.

FIELD DEFINITION – The page number is determined by the sequential order number of the page and the total number of pages. The remaining information is filled in accordingly.

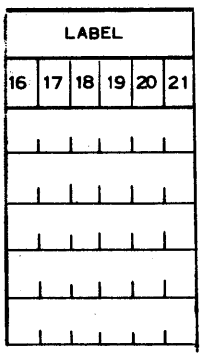
CODE	SEQUENCE				
1	11	12	13	14	15
			0	1	
			0	2	
			0	3	
			0	4	
			0	5	

SEQUENCE

DEFINITION – Identifies the sequential order of the operation codes. Applies only to punched card source programs.

FIELD DEFINITION – With a keyboard or paper tape source program the Basic Assembler assigns a sequence number to each line in increasing numerical sequence.

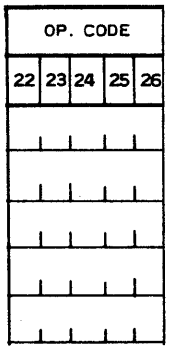
CODING
FORM



LABEL

DEFINITION – A symbolic designation utilized by the assembler to describe a parameter for a memory location or other parameter value.

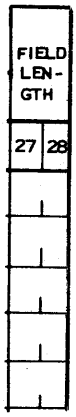
FIELD DEFINITION – A label consists of 1-6 alpha or numeric characters. The first character must be an alpha character. A label may be the same as a mnemonic operation code of any GP 300 instruction or assembler pseudo instruction. The label is entered in columns 16-21 and must be left justified.



OPERATION CODE

DEFINITION – The applicable symbolic instruction is entered in this field.

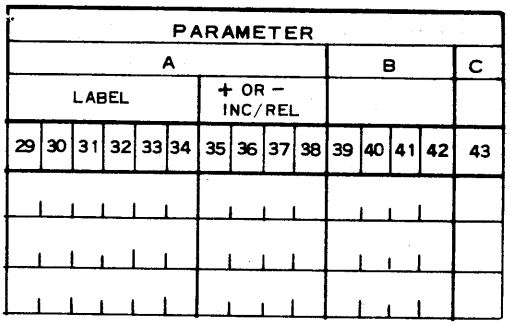
FIELD DEFINITION – Op. Code is entered in columns 22-26 and left justified.



FIELD LENGTH

DEFINITION – Indicates the number of characters or digits in the constants associated with certain instructions. Applies to punch card source programs only.

FIELD DEFINITION – Number of characters contained in required constant entered in columns 27-28 and right justified.



A PARAMETER – LABEL

DEFINITION – The applicable label or parameter is contained in this field.

FIELD DEFINITION – Label entries consist of 1-6 alpha or numeric characters and the first character must be an alpha character. The parameter or label is entered in columns 29-34 and left justified.

A PARAMETER – ± INCREMENT

DEFINITION – A signed numeric entry may be made in this field to denote a plus or minus value for incrementing or relative addressing with the label in columns 29-34 as a base. If a label is not used when using a branch instruction, the syllable location of the same instruction is used for the base address.

FIELD DEFINITION – If the field has a negative value, the "-" must be entered in column 35. For a positive value the "+" is optional. The increment is entered in columns 36-38 and right justified.

CODING FORM

B PARAMETER

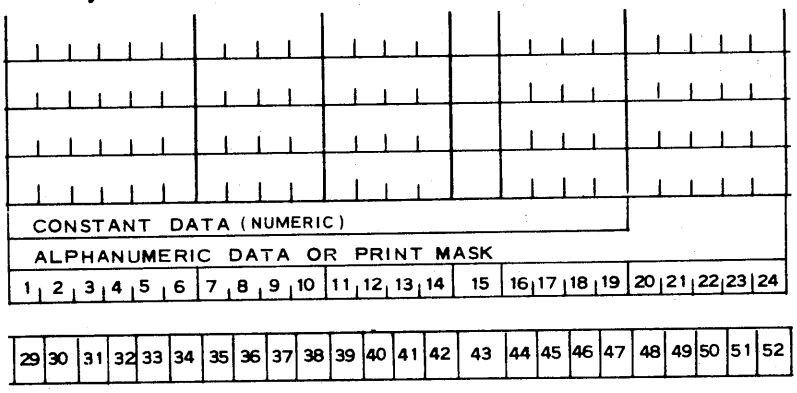
DEFINITION – The applicable alphanumeric entry is made in this field.

FIELD DEFINITION – Entry is made in columns 39-42 and left justified.

C PARAMETER

DEFINITION – The applicable numeric entry is entered in this field.

FIELD DEFINITION – Entry is made in column 43.



CONSTANT DATA (NUMERIC)

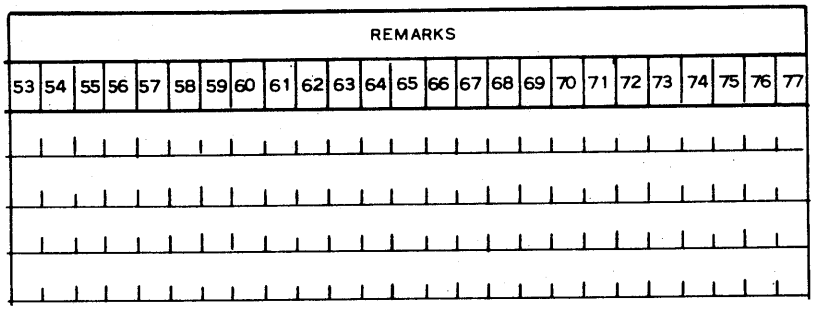
DEFINITION – Location of constant data for certain instructions.

FIELD DEFINITION – The constant is entered in columns 29-47 and is left justified.

ALPHANUMERIC DATA OR PRINT MASK

DEFINITION – Location of alphanumeric data for certain instructions.

FIELD DEFINITION – If the data is greater than 24 characters in length in a punched card source program, the excess characters are continued on the next line beginning in column 29 and preceded by a "CC" in columns 27. The continuation card must also contain the appropriate instruction in the Op Code field and a sequence number. Data is entered in columns 29-52 and left justified.



REMARKS

DEFINITION – Remarks may be entered in this field, and will appear in the printed documentation.

FIELD DEFINITION – Remarks are entered in columns 53-77 and left justified.

SECTION 2

GP 300 INSTRUCTIONS

INTRODUCTION

General Purpose Language (GP 300) is a programing language, consisting of machine instructions to control system operation, and is used for Series L/TC. For ease of programing the Series L/TC, the programmer can write his programs in symbolic language and can convert them to machine language through the use of an assembler program. By using an assembler program, the programmer is not burdened with keeping track of the memory location used, or the actual machine language for the symbolic instructions being used.

The GP 300 instruction list is implemented in the system by various Firmware Sets; the number of different instructions implemented is dependent on the particular Firmware Set used in the system. Firmware is defined as a control program, and is stored in a designated area of the systems memory. The firmware performs some of the logic and control functions, programmatically, that are usually performed by hardware electronic circuits in larger computer systems.

Firmware consists of "MICRO-programs" which implement each instruction of GP 300. A MICRO-program consists of a "string" of MICRO instructions, each performing a step to accomplish the function of the GP 300 instruction (referred to as MACRO instructions). Thus, in the execution of an applicational program, the firmware identifies each MACRO instruction used by the programmer, and selects the proper "MICRO string" to perform the function of the instruction.

MEMORY ORGANIZATION

Memory in the L/TC consists of 1,280 words of 64 bits each, and is organized into 5 blocks of 8 tracks each, or a total of 40 tracks. Each track containing 32 words. Main Memory is subdivided into two sections: The Control area and the Normal area.

The Control area contains the firmware which determine the system control functions and which implement the GP 300 instruction list. The Normal area is used to store the user's programs which are written with the MACRO instructions. The MACRO instructions are used by the programmer to exercise all of the capabilities of the L/TC such as arithmetic, logical comparisons, printing, input/output (paper tape or 80-column cards), and data transmission. The Normal area is also used for storing constant data, messages, and for accumulating totals. The amount of Normal area available to the user is dependent upon the firmware in the Control area (some firmware requires more memory than others).

MEMORY WORD ORGANIZATION

Each word of memory contains 16 digits (64 bits) and may be used to store one of the following:

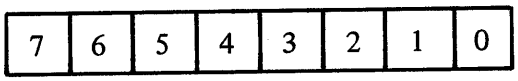
1. NUMERIC WORD

   15 digit positions
   1 flag position

FLAGS	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

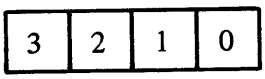
2. ALPHA WORD

8 alphanumeric characters, left justified.



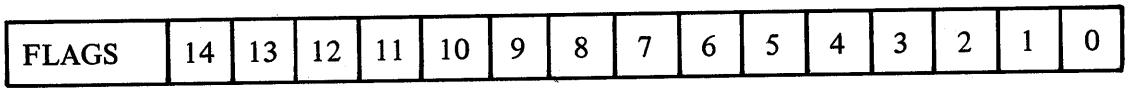
3. PROGRAM WORD

4 MACRO instructions per word.
4 Hexadecimal digits per instruction.



4. PRINT FORMAT WORD

15 control codes
1 flag position

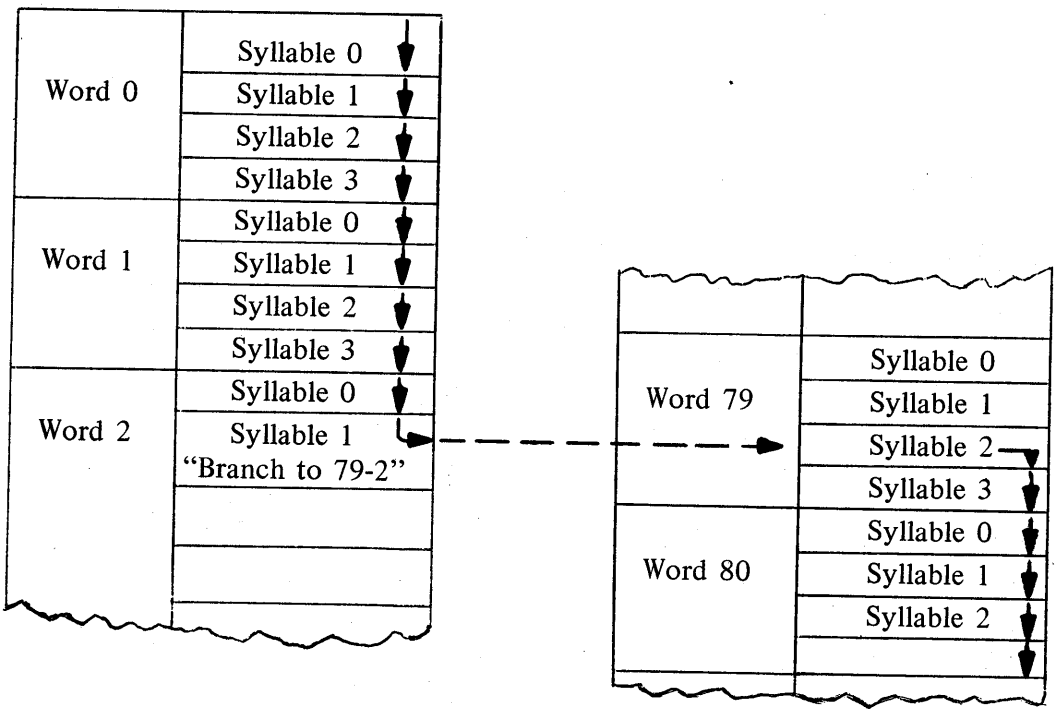


The words are addressed by a word number. The word number is an integer which lies between 0 and the highest available word to the user. The word number is sometimes referred to as memory address or memory location. If a word contains program, it is divided into four syllables, each syllable containing one instruction. The syllables are numbered 0, 1, 2, 3 as shown above within the word.

PROGRAM EXECUTION

When the system is activated and the program mode is entered by depression of the START key, execution of the program instructions begins in word 0, syllable 0. Execution continues sequentially by incrementing the syllable value by 1 (certain instructions can modify this procedure, i.e., a branch instruction). When the syllable value attains 3, the next increment will cause the word number to be increased by 1 and the syllable counter to be set back to 0. The current word number and syllable value are contained in the Program Counter.

The following example shows only word numbers and syllable values within those words. The arrows show how the values in the program counter are changed.



Sequential Program Execution and the effect of using the branch instruction

After the "START" key is depressed and program execution begins, the program counter always starts at word 0, syllable 0, it continues to be incremented until the execution of the instruction in word 2, syllable 1 (Branch instruction). After execution of this instruction causes the program counter to change value from word 2, syllable 1 to word 79, syllable 2, the program counter continues to increment until another path is selected.

ACCUMULATOR

Set aside from the Normal area of memory, is one word called the Accumulator. It, like other numeric words, contains 15 digits and a flag position. It is not addressed by a word number, but rather, access to it is a function of certain instructions. It is a working memory location for the movement of data from one area to another. It receives all numeric data entered through the keyboard including the keys that set the Accumulator flags [RE(-), C, M]; it must contain any numeric data to be printed; it can sum up several amounts and store the result in another word; it receives the product or quotient of computations; it must be used to accumulate one word of data into another; and it can be used to move alphanumeric information from one word to another.

When the Accumulator contains 0, the minus flag is reset (i.e., the Accumulator is positive).

Certain instructions will destroy the prior contents of the Accumulator (i.e., clear the Accumulator before the instruction is executed). This frees the programmer from clearing the Accumulator through instruction before moving data.

FLAGS

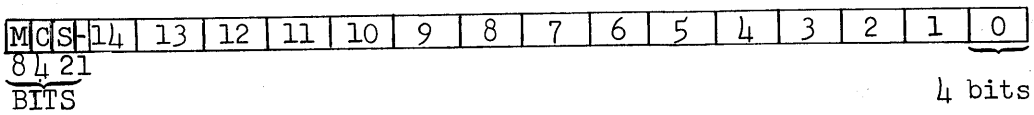
Instructions are provided to "test" whether or not certain conditions exist during the execution of the program, so that alternate paths of program may be selected, depending on the state of the condition being tested. In GP 300 the user has 28 "Flags" divided into 7 groups, each of which can be tested.

NK	NKCM
NKR	NKRCM

There are flags for testing the condition of the Accumulator, flags to test the condition of tape or card readers and tape or card punches, flags for the OCK Keys which the operator will use, flags for forms limits, index registers used to control loops, plus general purpose flags which the user can assign for his own particular needs.

Each flag consists of 1 "bit." When the bit is "ON," the flag is "Set"; when the bit is "off," the flag is "Reset." The program can interrogate a flag to test whether or not it is set or reset, and select a path of program accordingly.

A graphic explanation below of the Accumulator which has 4 flags will show how each flag is assigned one bit.



Accumulator Flags

(M) Per Thousand
(C) Per Hundred
(S) Special
(-) Minus or Negative

If we were to examine the bit configuration for the flags, they would be represented as follows:

Bits	(-)	(S)	(C)	(M)
8	o	o	o	•
4	o	o	•	o
2	o	•	o	o
1	•	o	o	o

KEYBOARD INSTRUCTIONS

ENABLE NUMERIC KEYBOARD INSTRUCTIONS

	OP CODE	A	B
NUMERIC KEYBOARD	NK	0-15	0-15
NUMERIC KEYBOARD, PERMIT REVERSE ENTRY	NKR	0-15	0-15
NUMERIC KEYBOARD, PERMIT C AND M KEYS	NKCM	0-15	0-15
NUMERIC KEYBOARD, PERMIT REVERSE ENTRY, C AND M KEYS	NKRCM	0-15	0-15

The four numeric keyboard instructions provide for the entry of a maximum of 15 digits of numeric information into the Accumulator digit positions 0-14. The Accumulator digit position 15 contains 4 flags designated "minus" (-), "special" (S), "per hundred" (C) and "per thousand" (M). These four flags are always reset at the start of any numeric keyboard or numeric entry instruction. The Reverse Entry Key (RE) allows for the entry of negative data into the Accumulator. The C, M Keys set the appropriate flag when depressed.

The "-," "C," "M" flags will be set if the particular keyboard instruction enables the use of their related keys (RE, C, M respectively) and the operator depresses these keys during the instruction. The special flag "S" cannot be set by the depression of any keyboard key. Control of this flag is accomplished by other means (see flag set/reset instructions).

The settings of the four flags transfer with the data from the Accumulator to memory and from memory back to the Accumulator and thus can be retained for future use in the program.

The A field specifies the maximum number of digits permitted to the left of the decimal point. The parameter values range from 0-15.

The B field specifies the maximum number of digits permitted to the right of the decimal point. The parameter values range from 0-15. The sum of the A and B parameter cannot exceed 15.

If either the A or B limits are exceeded, the Keyboard Error Indicator is turned on and the alarm bell sounds, halting the program. When the Keyboard Error Indicator is lit, all keys are disabled from performing their functions except the reset or ready push button. The entire entry must be re-indexed following the use of the reset key.

Other conditions which will cause the Keyboard Error Indicator to turn on:

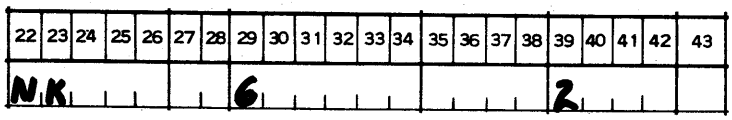
1. The RE, C, M Keys are depressed during a numeric keyboard instruction that does not permit their use.
2. A typewriter key is depressed (other than 0-9, open/close key, line advance key or typewriter OCK's) during a numeric keyboard instruction.
3. A non-enabled program key has been depressed.
4. A numeric keyboard instruction is initiated when the capacity of the keyboard buffer has been exceeded and when the valid codes in the buffer do not terminate the instruction.

Under control of the A field the programed number of digits enter the Accumulator. Although the B field specifies how many digits can be entered to the right of the decimal point, it also determines the digit position where the whole number enters the Accumulator. The entry of each whole number causes the previously indexed digits to shift left one digit position permitting the newly indexed digit to enter the vacated digit position. A zero key depression counts as a digit even if used as the most significant digit entry. Double and triple zero keys act in the same manner counting two or three digits respectively.

Under control of the B field (following recognition of the decimal point key), the first digit is entered to the right of the phantom decimal point and the second digit in the second position with the remaining digits entered accordingly. A zero counts as a digit even if entered as the last digit after the decimal point key. It is not necessary to depress the Decimal Point Key if there are no decimal entries, even though the B field permits decimals. When the B field is zero, the error light will not become activated if the decimal point key is depressed without ensuing digit keys.

Example:

Suppose the Accumulator digit positions 0-14 contain 0. Examine the instruction.



The operator wishes to index the number 5432.10.

The most significant digit "5" is indexed first and enters the Accumulator at digit position 2. The next digit "4" is indexed and enters the Accumulator at digit position 2 and shifts the 5 to digit position 3. This process continues until we have 000000000543200 in the Accumulator.

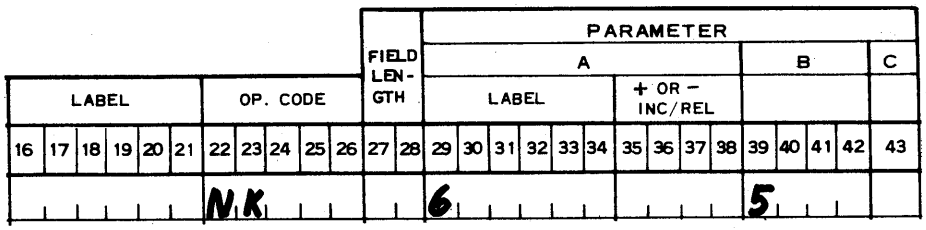
The decimal key is now used, and the digit 1 enters the first position to the right of the phantom decimal point. The next digit indexed enters in the next Accumulator digit position to the right of the previous entry. We now terminate the instruction with an appropriate OCK (i.e., according to program instructions).

The Accumulator now contains:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Accumulator Digit Position
F	0	0	0	0	0	0	0	0	0	5	4	3	2	1	0	Content of Accumulator

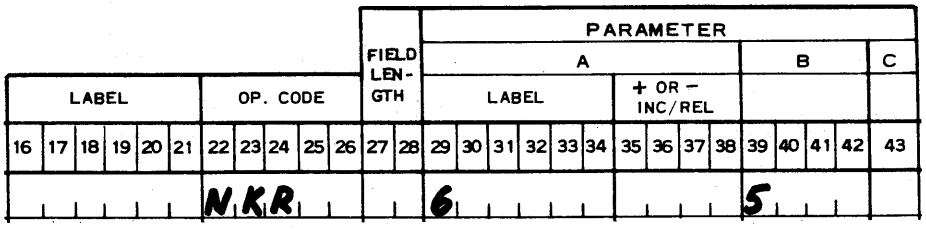
Numeric Keyboard Instructions Examples

Example 1: Illustrates the use of the NK instruction.



OP CODE	A	B	REMARKS
NK	6	5	Will allow for 11 characters to be entered into the Accumulator. No printing occurs. 6 to the left of digit position 5 and 5 to the right of it.

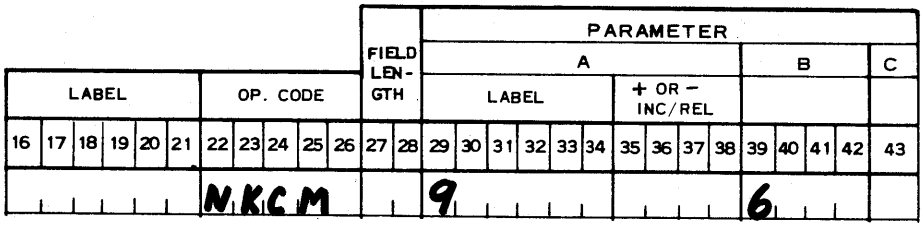
Example 2: Illustrates the use of the NKR instruction.



OP CODE	A	B	REMARKS
NKR	6	5	Will permit use of negative numbers (set minus flag).

PKA
PKB

Example 3: Illustrates the use of the NKCM instruction.



If the operator indexes 123456789 then the decimal point and 654321 the Accumulator contains in digit positions 0-14

123456789654321

If in addition the operator depresses the C or M key, the C or M flag will be set. Both keys can be used during the same instruction. Both flags will be set.

OPERATION CONTROL AND PROGRAM KEYS

Operation Control Keys (OCK'S) 1, 2, 3, 4

Depression of any of the Operation Control Keys (on either the numeric or typewriter keyboard) terminates the numeric or typewriter keyboard, sets the corresponding OCK flag, resets the other OCK flags, and causes the next instruction in the program to be executed. All program keys are turned off.

Enable Program Keys (PK) Instructions

	OP CODE	A	B
ENABLE PROGRAM KEY GROUP A	PKA	12345678	
ENABLE PROGRAM KEY GROUP B	PKB	12345678	
ENABLE PROGRAM KEY GROUP C	PKC	12345678	

The function of a Program Key is to select and execute one instruction programed and stored in an area of memory called a Program Key Table. It also will terminate a keyboard instruction instead of an OCK, in which case all OCK flags are reset.

Program Key Group A refers to Program Keys A1-A8. Program Key Group B refers to Program Keys B1-B8. Program Key Group C refers to Program Keys C1-C8. The allowable Program Key Groups are dependent upon the machine style. The A parameter can include any number of the program keys 1-8 for a specific group (A, B or C).

All PK's that are desired must be specified by the PK command for that group, as a later command calling for that group will void the effect of an earlier command for the same group.

When in the ready mode PK: A1, A2, A3 (Start, Load, Utility respectively) have specially assigned functions and are always enabled. In the ready mode the functions take precedence over any functions programed for these keys.

After an enable program key instruction the program will not stop automatically to allow the operator time to exercise a decision. This must be done by the programmer with an instruction such as TK.

LPKR

Load Program Key Base Register Instruction

	OP CODE	A	B
LOAD PROGRAM KEY BASE REGISTER	LPKR	LABEL	

The instruction Load Program Key Base Register is used to establish the first word of a four-word Program Key Table. (4 syllables per word). The A parameter is a label addressing the first word of the table.

The table must begin in Syllable 0 of a word. Each PK has one instruction in the table. They are arranged thusly:

BASE WORD	0	OP CODE for	PKA1
	1	OP CODE for	A2
	3	OP CODE for	A3
	4	OP CODE for	A4
BASE WORD +1	0	OP CODE for	A5
	1	OP CODE for	A6
	2	OP CODE for	A7
	3	OP CODE for	A8
BASE WORD +2	0	OP CODE for	B1
	1	OP CODE for	B2
	2	OP CODE for	B3
	3	OP CODE for	B4
BASE WORD +3	0	OP CODE for	B5
	1	OP CODE for	B6
	2	OP CODE for	B7
	3	OP CODE for	B8

There may be more than one PK table in memory at a time. The LPKR instruction must be used prior to changing the functions of the PK's in order to locate the base address of the new table.

OCK and PK Examples

Example:

LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	PKA		123			
	NK		0		0	

This example illustrates the use of an NK instruction to halt the program and allow the operator to select a PK key.

TYPEWRITER KEYBOARD INSTRUCTIONS

Load Keyboard Base Register Instruction

	OP CODE	A	B
LOAD KEYBOARD BASE REGISTER	LKBR	LABEL	

The LKBR instruction specifies the starting memory location into which information will be transferred for all succeeding TKM and EAM instructions. That is, until another LKBR instruction is executed. The A parameter addresses the starting word location in which the alpha characters will be stored.

The keyboard base register contains the location that is loaded into it until a subsequent LKBR instruction loads a new location into it.

This instruction is somewhat modified in firmware sets containing data communications capability. See Page 2-68.

Example:

LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	LKBR		TYPE			
	TKM		25			

The instructions above will allow 25 alpha characters to be stored sequentially beginning in the memory location addressed by the label TYPE.

TK
TKM

Type Instruction

	OP CODE	A
TYPE	TK	0-150 15" forms transport
	TK	0-255 26" forms transport

The type instruction provides for typing and printing as a maximum the number of alphanumeric characters as specified in the A field. The A parameter ranges from 0 to 150 for 15 inch forms transports, while 26 inch forms transport styles provide for a 0 to 255 range. This instruction is terminated by depression of an OCK or an enabled PK.
Printing of the first character will begin at the position of the print head. If printing in a specified area is required, the print head must be prepositioned to the beginning left-hand position of the print area before the typewriter instruction is reached in the program.

If typing of more than the number of characters specified in the A field is attempted, the Error Indicator is lit, and further typing is prevented. The error condition can be corrected by depression of the Reset Key. If the Reset Key is depressed during a TYPE instruction without an error condition, the instruction will be re-initiated and the print head will return to the beginning typing position.

Example:

			PARAMETER			
		FIELD LEN-GTH	A		B	C
LABEL	OP. CODE		LABEL	+ OR − INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	TK		9			

The above coding will allow the computer to act as a typewriter for 9 alpha characters.

Type into Memory Instruction

	OP CODE	A
TYPE INTO MEMORY PRINT	TKM	0-150 15" forms transport
	TKM	0-255 26" forms transport

The Type into Memory instruction differs from the Type instruction in that in addition to printing alphanumeric information, the characters are also stored in memory. The space character is considered a print character and stores a code in memory. The codes for Backspace, Open/Close, Line Advance, OCK's and Program Keys are not stored in memory.

Example:

LABEL						OP. CODE					FIELD LEN-GTH		PARAMETER A LABEL						+ OR − INC/REL				B				C
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
						T	K	M					3	1													

A maximum of 31 alpha characters will be entered into memory and typed. See LKBR instruction page 2-9.

This instruction is somewhat modified in firmware sets containing data communications capability. See Page 2-74.

The code, for each key depressed before instruction termination, is stored in memory with the first character stored in the most significant character location of the word specified by the keyboard base register. A single word can store 8 characters.

ALPHA WORD – (8 characters)

7	6	5	4	3	2	1	0

The depression of the backspace key effectively removes the last typing key code from memory. Backspacing will not occur past the first typing position.

On a TKM instruction each word is cleared before any characters are entered. The unused portion of the word remains clear. If no typing is done and the TKM instruction is terminated by an OCK, the word is clear. If exactly 8 characters were entered and then an OCK was used, the next sequential word in memory would be cleared. If a TKM is used again, without another LKBR, the data will enter memory at the first position of the last LKBR.

Note this is modified when used with Data Comm firmware. See SCP Page 2-68.

Enter Alpha into Memory Instruction

	OP CODE	A
ENTER ALPHA INTO MEMORY	EAM	1-150 15" forms transport
	EAM	1-255 26" forms transport

This instruction is identical to the TKM instruction except that printing does not occur. The print head does not escape.

LPNR

PRINT INSTRUCTIONS

MODES FOR PRINTING

Instructions are provided to print in three modes:

1. Alphanumeric printing of data either from keyboard entry or from memory. When printing in this mode, the field is left justified.
2. Printing of numeric data from Accumulator. In this mode printing is right justified.
3. Printing of a single character with the actual character specified by the instruction. A single character prints in the position indicated.

LOAD PRINT-NUMERIC BASE REGISTER INSTRUCTION

	OP CODE	A
LOAD PRINT-NUMERIC BASE REGISTER	LPNR	LABEL

The Print Numeric Base Register is loaded with the value of the "A" field to designate the word number of the base address for the print mask table. All succeeding print instructions reference this table until another LPNR instruction is executed. The "A" parameter designates the base address of the print mask table.

Mask words are grouped into a table in memory. A Print Numeric Base Register contains the base address or starting word of the table. The location of a mask word is the specified mask number relative to the base address contained in the register.

Example:

			FIELD LEN-GTH	PARAMETER			
				A		B	C
LABEL	OP. CODE			LABEL	+ OR − INC/REL		
16 17 18 19 20 21	22 23 24 25 26		27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	LPNR			FØRMAT			
	⋮						
FØRMAT	MASK			DD.D			
	MASK			ZZZ.DD			
	MASK			ZZZ,ZZZ,ZZZ.DD			

The Print-Numeric Base Register is loaded with the word number of the label (FORMAT). Mask number 0 would be DD.D. Mask number 1 would be ZZZ.DD, etc.

A maximum of 16 different masks can be referenced relative to the base address value in the Print Numeric Base Register. If more than 16 masks are required, the register must be reloaded with a new value before referencing the masks in the second table (by use of LPNR instruction), and then reloaded with the original value before reusing any of the first set of 16 masks. If fewer than 16 masks are required, those words of memory never referenced as mask numbers may be used for any other purpose.

MASK WORD (PRINT FORMAT)

The mask enables printing in varied formats. The mask word consists of control codes and control flags. The control codes are entered into the mask word in digit positions 0-14. They control the printing (or non-printing) and punctuation of each corresponding Accumulator digit. Mask flags are entered into digit position 15 of the mask word, and are used to modify the effects of the control codes.

TABLE OF MASK CONTROL CODES

NAME	CODE	PRINTING RESULT
Digit	D	Accumulator Digit prints unconditionally.
Decimal Point and Digit	.D	Decimal Point and Accumulator Digit print unconditionally.
Digit and Decimal Point	D:	Accumulator Digit and Decimal Point print unconditionally.
Digit and Comma	D,	Accumulator Digit and Comma print unconditionally.
Leading Zero Suppress	Z	Accumulator Digit prints if non-zero, or if a previous digit to the left was non-zero.
Leading Zero Suppress and Decimal Point	Z:	Accumulator Digit and Decimal Point print if digit is non-zero or if previous digit to the left was non-zero.
Leading Zero Suppress and Comma	Z,	Accumulator Digit and Comma print if digit is non-zero or if previous digit to the left was non-zero.
Units of Cents	C	Accumulator Digit prints if non-zero, if a previous digit to the left was non-zero, or if there is a non-zero digit in this terminal zero suppression field. Ignore if digit is zero and if significance is not established by either a preceding digit or a digit in this terminal zero suppression field.
Tens of Cents	.C	Decimal Point and Digit print if digit non-zero, or if significance is established by either a preceding digit or a digit in this terminal zero suppression field.

TABLE OF MASK CONTROL CODES (Continued)

NAME	CODE	PRINTING RESULT
		Ignore if digit is zero, and if significance is not established by either a preceding digit or a digit in this terminal zero suppression field.
Terminal Zero Suppress	X	Accumulator Digit prints if non-zero, or if any digit to the right in this terminal zero suppression field is non-zero.
Decimal Point and Terminal Zero Suppress	.X	Decimal Point and Digit print if digit or any succeeding digits in this terminal zero suppression field are non-zero.
		Ignore if the digit and all digits to the right in the terminal zero suppression field are zero.
Ignore Digit	I	Digit is ignored, printer does not escape.
Ignore Digit End	E	Digit is ignored, the print instruction is terminated, printer does not escape.
Single Digit Zero Suppress	S	Digit prints if non-zero. Escape if zero. Digits to the right and left have no effect.

TABLE OF MASK FLAGS

NAME	CODE	PRINTING RESULTS
Safeguard	F	When the Safeguard flag is set, the safeguard symbol ($) is printed to the left of the most significant digit printed.
Suppress Punction	+	Print positions where commas or decimal points would normally be inserted are replaced by spaces.
Punch Leading Zeros	P	No effect on printing, causes preceding zeros to punch even though they may not print, starting at the pointer.

Mask Word Examples

The usage of a mask word will be demonstrated by examples:

1. The Accumulator contains 000000009713456 in digit positions 0-14.
   a. To obtain the printed result 000000009713456 a mask of DDDDDDDDDDDDDDD in mask positions 0-14 can be used because the mask character D will unconditionally print the digit in the corresponding Accumulator digit position.

b. To eliminate the leading zeros in Accumulator digit positions 7-14 the printed mask can be ZZZZZZZZZZZZZZZ as the Z mask character will cause a non-print of a leading zero. The printed result will be 9713456.

2. The Accumulator contains 000000067010359 in digit positions 0-14.

   a. Print the Accumulator with a decimal point and the appropriate commas. A possible mask is ZZZ,ZZZ.DD which prints 670,103.59. Another possibility for the print mask is ZZZ,ZZZ.ZZ which gives the same printed result (provided the Accumulator is not zero in every digit position).

   b. Characters are also provided to permit monetary punctuation. To print the contents of the Accumulator with the format $670,103.59 a mask composed of FZZZ,ZZZ.CC could be used or FZZZ,ZZZ.DD would provide the identical results for this case (provided the Accumulator is not zero in every digit position).

3. Allow the Accumulator to contain 000000380502267 in digit positions 0-14.

   a. To format the printed result in the form of a social security number the Suppress Punctuation Flag (+) can be set. +DDD,DD,DDDD would allow the printed result 380 50 2267 as the Suppress Punctuation Flag replaces the commas and periods with spaces.

   b. The mask ZZZZZZDDIDIDDDD would format the print thusly 3852267. The I character ignores the digit in the corresponding Accumulator digit position and the printer does not escape.

As we will see due to the PN instruction, the mask need not fill the entire mask word.

LOAD POSITION REGISTER INSTRUCTION

	OP CODE	A
LOAD POSITION REGISTER	POS	1-150 15" forms transport
	POS	1-255 26" forms transport

The Position Register is loaded with the value of the A field. The A field ranges from 1 to 150 for 15 inch forms transports and 1-255 for 26 inch forms transports. The position loaded in the position register corresponds with the actual position at which the printer will print. The print ball does not move until the program reaches an instruction which specifies that a character is to be printed, or until a keyboard instruction is reached. The print head escapes in 1/10 inch increments.

SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
01		POS		101			
02		AL		1			
03		TK		36			

The above instruction will position at position 101 or 10 inches from position 1.

PA
PN

PRINT ALPHANUMERIC FROM MEMORY INSTRUCTION

	OP CODE	A
PRINT ALPHANUMERIC	PA	LABEL

The Print Alphanumeric instruction prints alphanumeric information from memory beginning with the first character in the memory location specified by the "A" field. Printing continues until an end of alpha code is encountered, regardless of the number of words used.

For the PA instruction, the ribbon will be in the normal (generally black) position, although it can be changed to the reverse position by other instructions.

Example:

Suppose the alpha characters MESSAGE (and an end alpha code) are stored in memory location SAVE and we desire to print the contents of this memory location.

Initially, we position the print head. The second step is to provide for the actual printing. These two steps are programed.

				PARAMETER			
			FIELD LEN-GTH	A		B	C
LABEL	OP. CODE			LABEL	+ OR − INC/REL		
16 17 18 19 20 21	22 23 24 25 26		27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	PØS			95			
	PA			SAVE			

The printed message would appear at print position 95, left justified and read MESSAGE.

NUMERIC PRINTING INSTRUCTIONS

Numeric values to be printed must be contained in the Accumulator and can have a maximum of 15 digits. It is not possible to print numeric data directly from memory.

Print Numeric

	OP CODE	A	B
PRINT NUMERIC	PN	0-14	0-15

The Print Numeric instruction prints the contents of the Accumulator with the ribbon in the normal (generally black) position regardless of sign. (Unless previously shifted by the RR instruction.)

The "A" field contains the Accumulator digit position number for the most significant digit to be printed. This is independent of the print mask. All positions higher than the digit position specified are ignored and lost from printing. Since the Accumulator digit positions start with 0, to print out a maximum of 5 digits the "A" parameter should contain a 4.

The "B" field of this instruction identifies the print mask to be used during printing. There is a maximum of 16 print masks per LPNR instruction so the B field contains a value from 0-15. The value referenced in the B field is a function of the mask table. (See LPNR instruction).

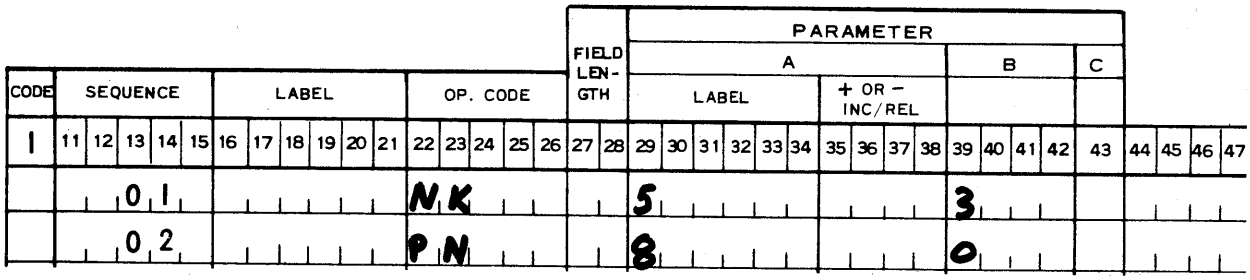
	OP CODE	A	B
PRINT NUMERIC, SHIFT RIBBON IF MINUS	PNS–	0-14	0-15
PRINT NUMERIC, SHIFT RIBBON IF PLUS	PNS+	0-14	0-15

The PNS– and PNS+ instruction are similar to the PN instruction, the difference being:

1. The PNS– instruction shifts the ribbon if the sign of the Accumulator is negative.
2. The PNS+ instruction shifts the ribbon if the sign of the Accumulator is positive.

Examples:

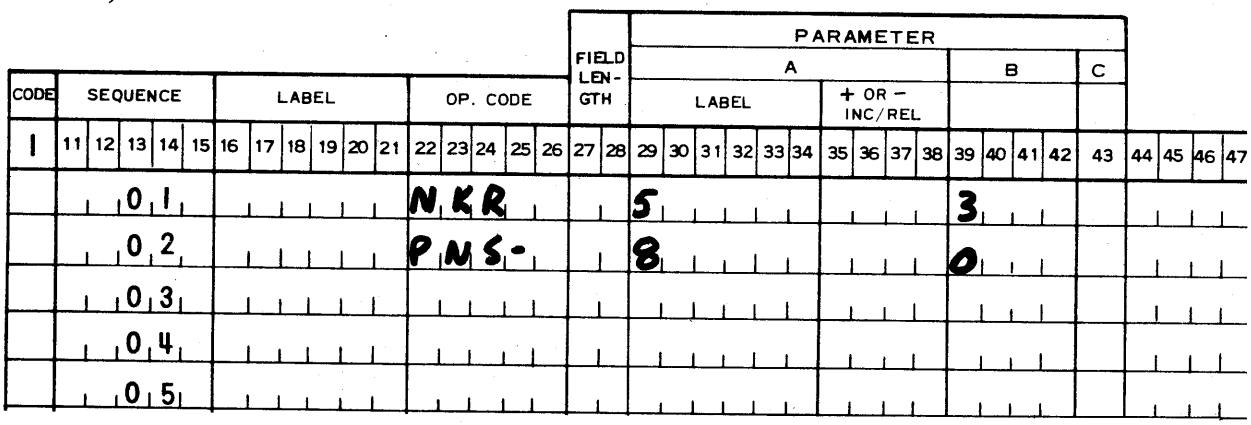
a)



LABEL	OP CODE	A	B	REMARKS
	NK	5	3	Enable Numeric keys
	PN	8	0	Print Accumulator contents

The contents of the Accumulator are printed beginning with digit position 8 and with the format dictated by print mask 0.

b)



PC	PC–
PCP	PC+

LABEL	OP CODE	A	B	REMARKS
	NKR	5	3	Enable Reverse Entry
	PNS–	8	0	Print Shift if negative

Printing will occur as in the above example, but the ribbon will Shift if the Accumulator "minus" flag is set.

SINGLE CHARACTER PRINT INSTRUCTIONS

	OP CODE	A
PRINT CHARACTER	PC	Character to be printed

This instruction unconditionally prints the character specified in the "A" field. If the "A" field is blank, the instruction causes a single printer space operation. The PC instruction prints with the ribbon in the normal position (unless previously shifted. See RR instruction).

	OP CODE	A
PRINT CHARACTER PREVIOUS RIBBON	PCP	Character to be printed

The PCP instruction will print a character with the same ribbon position that was used on the last print operation.

	OP CODE	A
PRINT CHARACTER IF ACCUMULATOR MINUS, PREVIOUS RIBBON	PC–	Character to be printed
PRINT CHARACTER IF ACCUMULATOR PLUS, PREVIOUS RIBBON	PC+	Character to be printed

Printing of these instructions is dependent upon the Accumulator sign flag (+ or –). The character specified in the "A" field is printed according to the following conditions:

1. PC– Print if Accumulator negative (i.e., sign flag set); do not print if plus.
2. PC+ Print if Accumulator positive (i.e., sign flag reset); do not print if negative.

Example:

SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR – INC/REL	PARAMETER B	PARAMETER C
11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
01		NKR		8		3	
02		PC+		+			
03		PC-		-			

RR

LABEL	OP CODE	A	B	REMARKS
	NKR	8	3	Allow negative entry
	PC+	+		Print if positive
	PC–	–		Print if negative

If the Accumulator contains a positive quantity, a "+" character will be printed. A negative content would produce a "–" character.

RIBBON SHIFT INSTRUCTION

Printing of data normally is with the ribbon color black, except for certain print instructions that cause minus amounts to print in red. However, a ribbon shift instruction is provided to change the normal color of printing.

	OP CODE	A	B
RED RIBBON	RR		

The RR instruction is used to change the ribbon color of only the next printing instruction. The ribbon color will be opposite to the color normally expected from the data and type of the next print instruction.

Examples:

a)

				FIELD LEN-GTH	PARAMETER			
					A		B	C
CODE	SEQUENCE	LABEL	OP. CODE		LABEL	+ OR – INC/REL		
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43 44 45 46 47
	01		NKR		8		3	
	02		RR					
	03		PN		5		3	
	04		PN		5		3	

LABEL	OP CODE	A	B	REMARKS
	NKR	8	3	Allow negative entry
	RR			Reverse Ribbon
	PN	5	3	
	PN	5	3	

The Accumulator contents would print according to the PN 5 3 instruction but the ribbon would change to the opposite color. The second PN 5 3 would not be affected by the RR instruction.

OC
CC

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	01		NKR		8		3	
	02		RR					
	03		PNS-		11		0	
	04		RR					
	05		PNS+		11		0	

LABEL	OP CODE	A	B	REMARKS
	NKR	8	3	Allow negative
	RR			Reverse Ribbon
	PNS–			Shift Ribbon "–"
	RR			Reverse Ribbon
	PNS+			Shift Ribbon "+"

The effects of the PNS– and PNS+ instruction are nullified.

FORMS CONTROL INSTRUCTIONS

FORMS TRANSPORT – OPEN AND CLOSE INSTRUCTION

	OP CODE	A
OPEN FORMS TRANSPORT	OC	0-255 rear feed transport
	OC	BLANK front feed transport

The OC instruction is used to open the forms transport mechanism in order to permit the insertion or removal of a completed unit document. The A parameter is blank for front feed styles. For rear feed styles of the L/TC the A parameter of the OC instruction specifies the number of lines the left forms mechanism will advance when the transport mechanism is next closed.

This closing may be from any of the following sources:

1. The execution of a PN or PA instruction of any type.
2. The entering of alpha information at a TK instruction. If a TK instruction were terminated by an OCK without the entering of alpha data, the transport mechanism would not close.
3. A CC instruction.
4. Manual depression of the open/close key on the keyboard.

	OP CODE
CLOSE FORMS TRANSPORT	CC

LLCR		LLLR
LRCR		LRLR
AL	AR	ALR
ALTO		ARTO

The CC instruction closes the forms transport. This instruction generally is not required since execution of any print instruction or depression of a typing key during a type instruction will automatically close the forms transport.

If the transport is open as the result of executing an OC instruction, when the CC instruction is executed, the Left Forms mechanism will advance the number of times specified by the OC instruction.

PLATEN CONTROL REGISTER INSTRUCTIONS

	OP CODE	A
LOAD LEFT PLATEN COUNT REGISTER	LLCR	0-255
LOAD LEFT PLATEN LIMIT REGISTER	LLLR	0-255
LOAD RIGHT PLATEN COUNT REGISTER	LRCR	0-255
LOAD RIGHT PLATEN LIMIT REGISTER	LRLR	0-255

The programmer is provided with four platen control registers to control vertical spacing. These are the Left and Right Forms Count Registers, and the Left and Right Limit Registers. In addition, there is a Forms Limit Flag.

A forms count register is associated with each platen advance mechanism. This register is automatically incremented by 1 each time the respective (left or right) platen is advanced a line.

A forms limit register is also associated with each platen advance mechanism. This register contains a limit to which the forms count register can be compared.

The LLLR and LRLR preset the forms limit registers to a specified line. The count register will be set to 1 (not 0) on the next line advance after the respective limit and count registers are equal.

On the line advance following when the count register equals the corresponding limit register, the forms limit flag is set. The limit flag becomes reset on the next line advance.

The execution of a LLCR or LRCR will reload the appropriate count register. The count register is not incremented when the platen is advanced by the platen twirlers.

The LLLR and LRLR instructions load the Left and Right Platen Limit Registers respectively with the contents of the "A" field.

The LLCR and LRCR instructions load the Left and Right Platen Count Registers respectively with the contents of the "A" field.

LINE ADVANCE INSTRUCTIONS

	OP CODE	A
ADVANCE LEFT PLATEN	AL	0-255
ADVANCE RIGHT PLATEN	AR	0-255
ADVANCE BOTH PLATENS	ALR	0-255
ADVANCE LEFT PLATEN TO	ALTO	1-255
ADVANCE RIGHT PLATEN TO	ARTO	1-255

The AL, AR, and ALR instructions advance the form the number of lines specified by the "A" parameter. These provide a single line advance with a maximum advance of 255 lines. The vertical spaces occur in the 1/6 inch increments. The respective count register is incremented by 1 for each single line advance.

The ALTO and ARTO instructions advance a form until the associated count register is equal to the value of the "A" field. If the Count Register equals the line number specified in the ALTO or ARTO instruction prior to its execution, no advance occurs. Specifying "0" or an integer larger than the contents of the Limit Register in the "A" parameter of the ALTO/ARTO instruction is a programing error. This will result in a continuous search for a line number that does not exist.

1. The use of LLCR and LLLR

   LLLR = 50
   LLCR = 50

   On the next line advance the left count register equals 1 and the Forms Limit Flag will be set. The next line advance (2nd after LLCR = LLLR) resets the flag.

2. To determine the number of lines which will be advanced, subtract the Count Register from the value of the "A" parameter in the ALTO or ARTO instruction. If positive, this will be the number of lines advanced. If negative, assume this number is positive, then subtract from the value of the Limit Register to ascertain the number of lines advanced.

   a.

OP CODE	A	REMARKS
LLLR	255	Load Left Limit Register
LLCR	20	Load Left Count Register
ALTO	3	Advance to line 3

   Value of ALTO parameter – Value of Count Register

   3 – 20 = –17

   Since negative assume positive (i.e., –17 = 17)

   Value of Limit Register – 17 =

   255 – 17 = 238

   There will be an advance of 238 lines.

   b.

OP CODE	A	REMARKS
LLLR	255	Load Left Limit Register
LLCR	20	Load Left Count Register
ALTO	25	Advance to Line 5

   Value of ALTO parameter – Value of Count Register =

   25 – 20 = 5

   Since resultant is positive, there will be 5 line advance.

3.

OP CODE	A
LLLR	30
ALTO	5

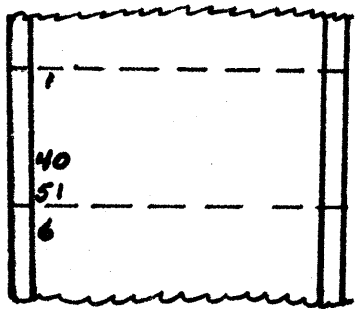
Assume contents of Left Count Register = 20, when ALTO command is executed. This is an example of the type of programing employed when using pin fed continuous forms with the requirement that the program automatically advance from the last line on one form to the first line of a new form.

The form advances 10 lines, then the LLLR = LLCR, on the next line advance the Count Register is set to 1. Advancing continues for 4 more lines to line 5 of the new form. In this case, the last line on the form would be line 30.

Another method of continuous forms programing utilizes the forms limit flag.

Example:

Suppose we have the following form:



The following programing will advance the form automatically when the forms limit flag is set.

OP CODE	A	B	C
LLLR	40		
LLCR	6		
AL	1		
EX	T	L	2
ALTO	17		
LLLR	6		

4. When programing for automatic alignment of rear-fed unit documents, the number that must be placed in the OC parameter must be 3 greater than the line number of the first actual line of print.

   To align a unit document to line number 14

OP CODE	A	REMARKS
OC	17	Will align to 14

   Although the form aligns to line 14, the Count Register contains 17. Thus, it may be desirable to reload the Count Register with 14 before any further vertical spacing is performed.

   a. Use of the Limit Register to enable the program to know when 40 lines have been filled on the invoice. The total length of the invoice is 8½ inches (8.5 x 6 = 51 lines). The first print line is 14 as measured from the top of the form.

OP CODE	A
LLLR	40
LLCR	37
OC	17
TK	10

ADK	
ADA	ADM

When the forms transport is closed, the form will advance 17 lines. The first three lines increment the Count Register to 40, the next advance will set the Count Register to 1. After an advance of the remaining 13 lines, the Count Register will be at 14. This is the actual first line number, and the number wanted in the Count Register.

5. AL – AR – ALR

The AL, AR, or ALR instructions advance the form the exact number of lines specified by the parameter field. The most common use is to advance 1 line.

OP CODE	A
AL	1

The form will advance 1 line. The Count Register will be incremented by 1.

ARITHMETIC AND DATA MOVEMENT INSTRUCTIONS

ADD CONSTANT TO ACCUMULATOR INSTRUCTION

	OP CODE	A	B
ADD CONSTANT TO ACCUMULATOR	ADK	0-14	0-9

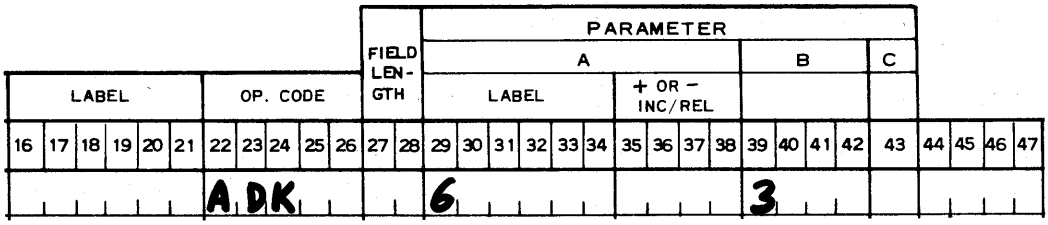
The ADK instruction provides algebraic addition of the digit contained in the B field to the digit in the Accumulator position specified by the A field, with carries propagated in succeeding high order digits.

The Special (S), per thousand (M) and per hundred (C) flags are unconditionally reset.

The sign flag is reset (+) if the result is positive or set (–) if negative.

The overflow flag is set if an overflow occurs and reset if there is no overflow.

Example:



OP CODE	A	B	REMARKS
ADK	6	3	Add 3 to digit position 6 in the Accumulator.

ADDITION INSTRUCTION

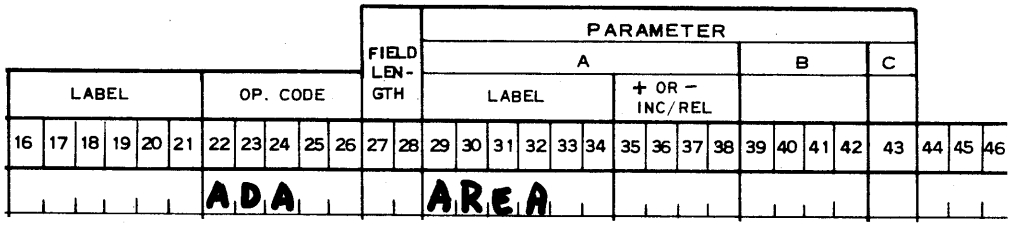
	OP CODE	A
ADD TO ACCUMULATOR	ADA	LABEL
ADD TO MEMORY	ADM	LABEL

The ADA instruction provides for adding the contents of a memory location, specified by the A field to the contents of the Accumulator. The resultant sum is placed in the Accumulator leaving the memory location undisturbed.

The ADM instruction provides for adding the contents of the Accumulator to the contents of the memory location specified in the A field. The resultant sum is placed in memory location A leaving the Accumulator undisturbed.

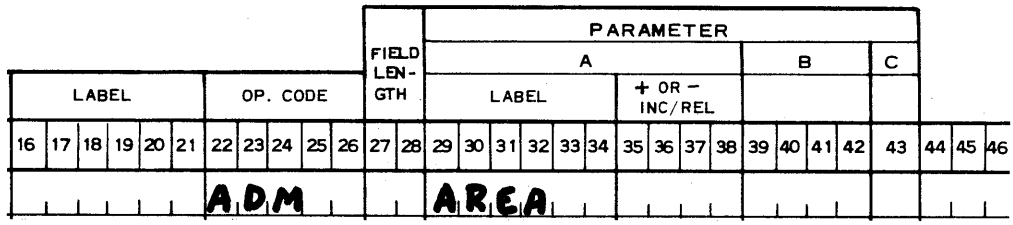
The ADA and ADM commands cannot be used to move alpha data, even if the receiving location is clear.

Example:



OP CODE	A	B	REMARKS
ADA	AREA		Add to Accumulator the contents of Area, content of Area is unchanged.

Example:



OP CODE	A	B	REMARKS
ADM	AREA		Add to memory location Area contents of Accumulator leaving Accumulator unchanged.

CLEAR INSTRUCTIONS

	OP CODE	A	B
CLEAR MEMORY WORD	CLM	LABEL	
CLEAR ACCUMULATOR AND INSERT CONSTANT	CLA	0-15	0-15

The CLM instruction will clear the 16 digits of the memory location specified in the A field.

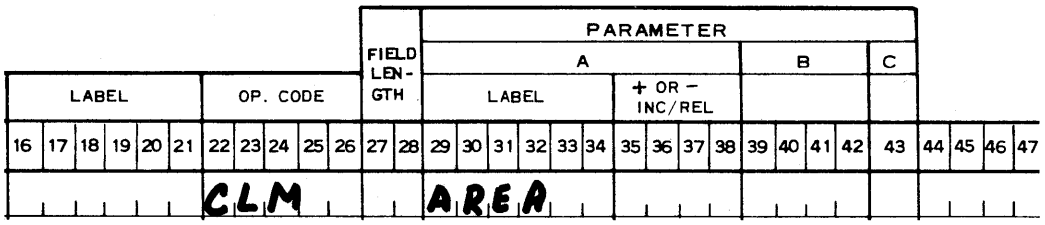
The CLA instruction sets all 16 digits of the Accumulator to zero, thus resetting the four Accumulator flags (M, C, special, and sign); it places the digit specified by the B field in the digit position of the Accumulator specified by the A field.

INK

It is important to notice that the B parameter although expressed as 0-15 on the coding form, is placed in the Accumulator as a hexadecimal digit (0-F) rather than two decimal digits.

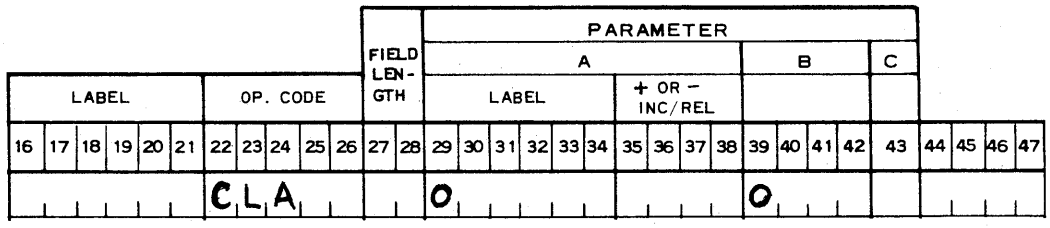
Arithmetic operations can only use the values from 0-9 in any digit position. Any values over 9 would be lost during arithmetic.

Example:



OP CODE	A	B	REMARKS
CLM	AREA		The Memory location called Area will contain all zeros.

Example:



OP CODE	A	B	REMARKS
CLA	0	0	The Accumulator contains zeros in positions 0-15.

INSERT CONSTANT IN ACCUMULATOR INSTRUCTION

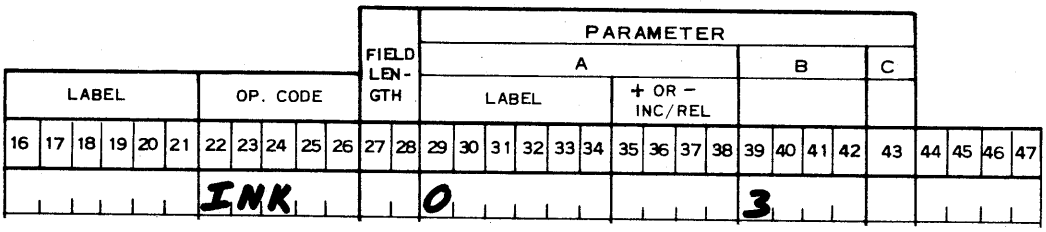
	OP CODE	A	B
INSERT CONSTANT IN ACCUMULATOR	INK	0-15	0-15

The INK instruction places the digit specified by the B field in the digit position of the Accumulator specified by the A field. The remaining digit positions are unaffected. The overflow flag is not changed.

Similar to the CLA instruction the B parameter field in this instruction also permits entry of a value from 0-15. Again this is a hexadecimal value rather than a decimal value.

Arithmetic operations can only use the values 0-9 in any digit position. Any values over 9 (i.e., A-F) would be lost during arithmetic.

Example:



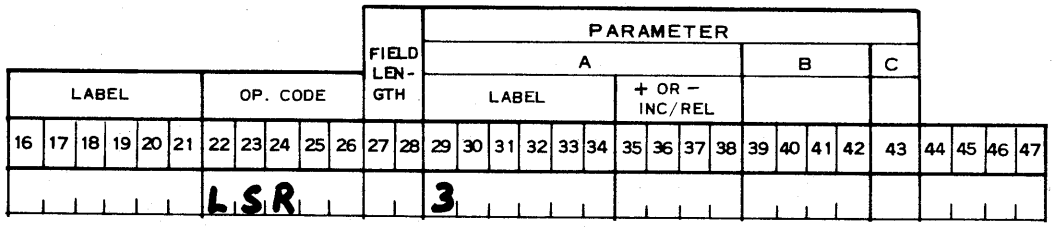
OP CODE	A	B	REMARKS
INK	0	3	The digit 3 will be placed in Accumulator digit position 0 replacing the previous contents of Accumulator digit position 0.

MULTIPLICATION AND DIVISION INSTRUCTIONS

Load Shift Register Instruction

	OP CODE	A	B
LOAD SHIFT REGISTER	LSR	0-15	

The LSR instruction provides for loading the multiply-divide shift register with the contents of the A field. The shift register must be loaded prior to the execution of a Multiply or Divide instruction. The shift register will contain the value loaded until a subsequent load shift register command is executed. For multiplication, the shift register designates the number of places the product is shifted right after multiplication. The shifted off digits are lost, the remaining digits set in the Accumulator as the product. Division will be carried out to the number of places specified in the shift register. These operations take into account the shift register even though it is not loaded immediately preceding each MUL or DIV instruction. The contents of the shift register must be changed only when the shift requirements are changed.



OP CODE	A	REMARKS
LSR	3	Load shift register with 3

Computing the Value of the Shift Register

FOR MULTIPLICATION–To compute the value which must be loaded in the shift register, subtract the desired number of decimal places in the final result from the sum of decimal places in the multiplier and multiplicand.

MUL

Number of places in multiplier	+	Number of places in multiplicand	–	Desired Number of places	=	Value of Shift Register
100.00		.25				
2	+	2	–	1	=	3

Accumulator contains 250 digit positions 0-2, when printed with one decimal this becomes 25.0.

FOR DIVISION–The value to be loaded into the Shift Register can be determined with a knowledge of the assumed decimal places needed in the quotient as well as the divisor and dividend.

Assumed decimal places in divisor	+	Assumed decimal places quotient	–	Assumed decimal places dividends	=	Value of Shift Register
.25		100.00		25.0		
2	+	2	–	1	=	3

Multiply Instructions

	OP CODE	A
MULTIPLY	MUL	LABEL

The multiply instruction provides for multiplying the contents of the Accumulator by the contents of the memory location specified in the A parameter. The product is shifted right the number of places specified in the multiply – divide shift register, causing the shifted off digits to be lost. The next 15 low order digits are placed in the Accumulator as the product.

If the Accumulator and the memory location in the A parameter have identical signs, the sign of the product is positive [Accumulator sign flag is reset (+)]. With unlike signs, the product is assigned a negative sign [Accumulator sign flag is set (–)].

Both the Accumulator and the memory location can contain a maximum of 15 digits each. If the product contains more than 15 digits after shifting occurs, the excess number of digits are lost and the overflow flag is set. The flag is reset otherwise. (In the event of an overflow there is not an indication light).

If the possibility of an overflow condition exists, the program should provide for interrogating the flag to determine if a corrective routine should be employed.

The number of significant digits in the multiplier (memory location in the A field) determines the length of time for the execution of the multiplication instruction. The number of digits in the multiplicand (Accumulator) has no effect on the timing.

Example:

				FIELD LEN-GTH	PARAMETER			
					A		B	C
LABEL		OP. CODE			LABEL	+ OR – INC/REL		
16 17 18 19 20 21		22 23 24 25 26		27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
		MUL			PRICE			

MULR
DIV

OP CODE	A	REMARKS
MUL	PRICE	Multiply Accumulator by PRICE

Multiply and Round Instruction

MULTIPLY AND ROUND INSTRUCTION

OP CODE	A
MULR	LABEL

The MULR instruction is the same as the MUL instruction except that a 5 is added to the last digit which was shifted off in the product. The product contained in the Accumulator is increased by 1 (decreased if –) if the last digit shifted off was greater than or equal to 5. If the shift register value is zero, there will be no rounding.

Divide Instruction

DIVIDE

OP CODE	A
DIV	LABEL

The DIV instruction divides the contents of the Accumulator by the contents of the memory location specified in the A field. The quotient is placed in the Accumulator. After division has been carried out, the number of decimal places specified in the shift register, any remainder is placed in working memory (in the control area). (See REM instruction.)

Both the Accumulator and the memory location can contain a maximum of 15 digits each. If the signs of the Accumulator and memory location are the same, the sign of the quotient is positive (Accumulator sign flag is reset +). With unlike signs, the quotient is negative (Accumulator sign flag is set –). A remainder is positive.

If the quotient after final shift exceeds 15 digits, the overflow flag is set; otherwise, the flag is reset. When an overflow occurs, the division is halted and the result in the Accumulator is meaningless. The size of the quotient can be estimated and a prediction of possible overflow made if the following rule is used:

> "Add the MAXIMUM size DIVIDEND (Accumulator) to the Value of the SHIFT REGISTER plus 1, subtract the MINIMUM size Divisor and that equals the MAXIMUM size Quotient possible."

An attempt to divide a number by zero sets the overflow flag and produces an undeterminable answer. Division of zero by any number results in a zero quotient.

Example:

		FIELD LEN-GTH	PARAMETER			
			A		B	C
LABEL	OP. CODE		LABEL	+ OR – INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	DIV		TOTAL			

OP CODE	A	REMARKS
DIV	TOTAL	Divide Accumulator by TOTAL

SUA
SUK

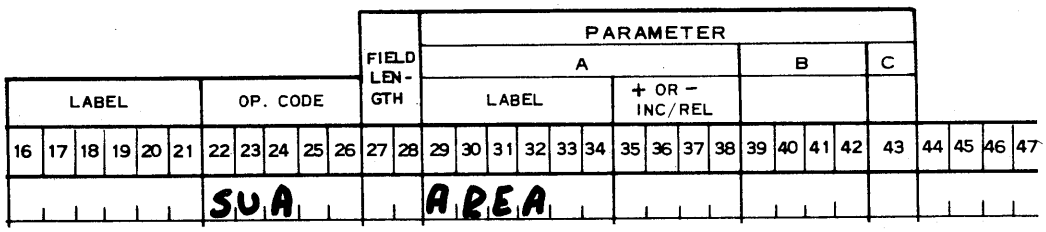
SUBTRACT INSTRUCTIONS

	OP CODE	A	B
SUBTRACT FROM ACCUMULATOR	SUA	LABEL	
SUBTRACT CONSTANT FROM ACCUMULATOR	SUK	0-14	0-9

The SUA instruction provides for subtracting the contents of the memory location specified by the A field from the contents of the Accumulator. The difference is placed in the Accumulator leaving memory location A undisturbed.

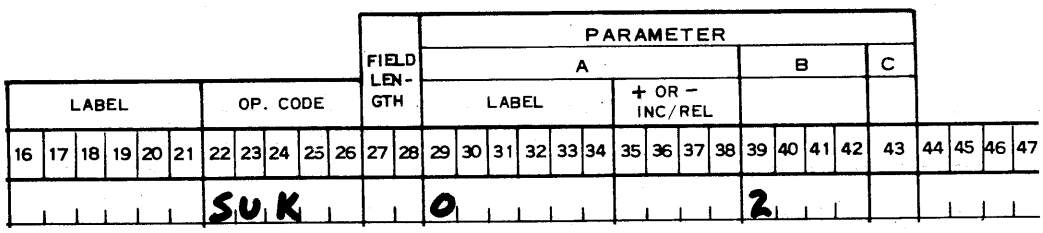
The SUK instruction provides algebraic subtraction of the digit contained in the B field from the digit in the Accumulator position stated in the A field with carries propagated in succeeding high order digits. (The special (S), per thousand (M), and per hundred (C) flags are unconditionally reset.)

Example:



OP CODE	A	B	REMARKS
SUA	AREA		Subtract the contents of the memory location called Area from the Accumulator.

Example:



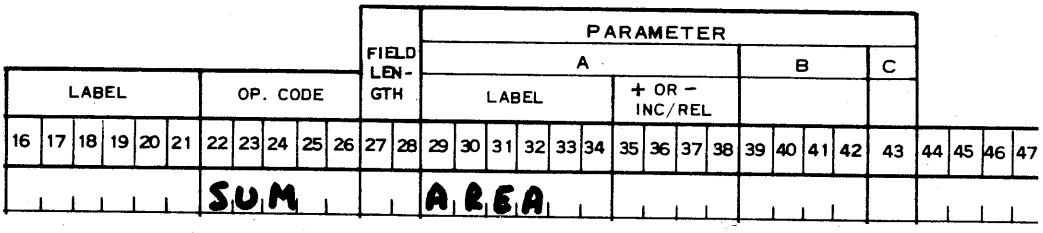
OP CODE	A	B	REMARKS
SUK	0	2	Algebraic subtraction of the integer 2 from the 0 digit position in the Accumulator

	OP CODE	A	B
SUBTRACT FROM MEMORY	SUM	LABEL	

The SUM instruction provides for subtracting the contents of the Accumulator from the contents of the memory location specified in the A parameter.

The difference is placed in the given memory location, leaving the Accumulator unchanged.

Example:



OP CODE	A	B	REMARKS
SUM	AREA		Subtract the contents of the Accumulator from the memory location called Area.

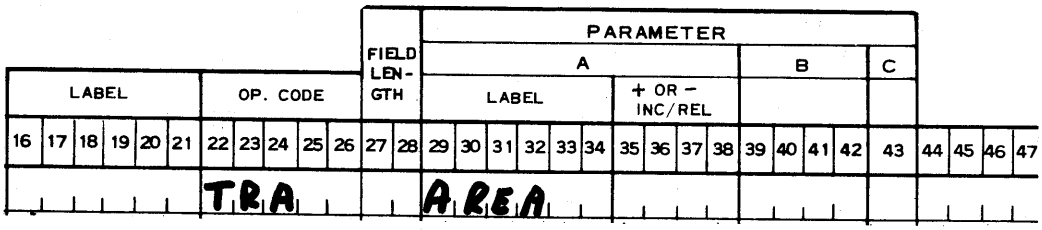
TRANSFER INSTRUCTIONS

	OP CODE	A	B
TRANSFER TO THE ACCUMULATOR	TRA	LABEL	
TRANSFER TO MEMORY	TRM	LABEL	

The TRA instruction provides for transferring the contents of the memory location specified in the A field to the Accumulator, keeping the contents of the memory location unchanged.

The TRM instruction provides for transferring the contents of the Accumulator to the memory location specified by the A field. There is no change in the contents of the Accumulator.

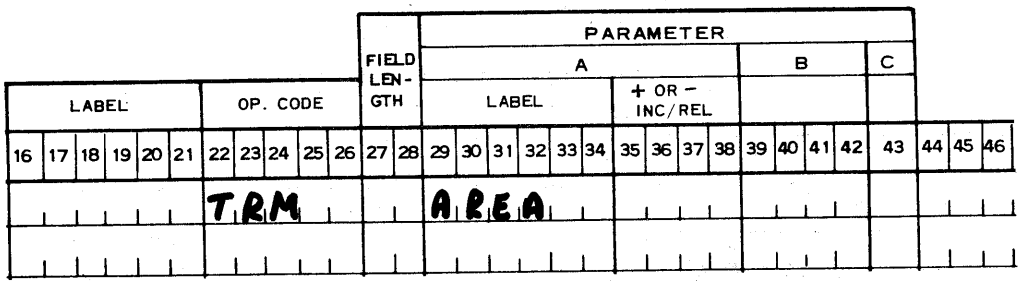
Example:



OP CODE	A	B	REMARKS
TRA	AREA		Transfer the contents of memory location Area to Accumulator. Memory location unchanged.

SLRO

Example:

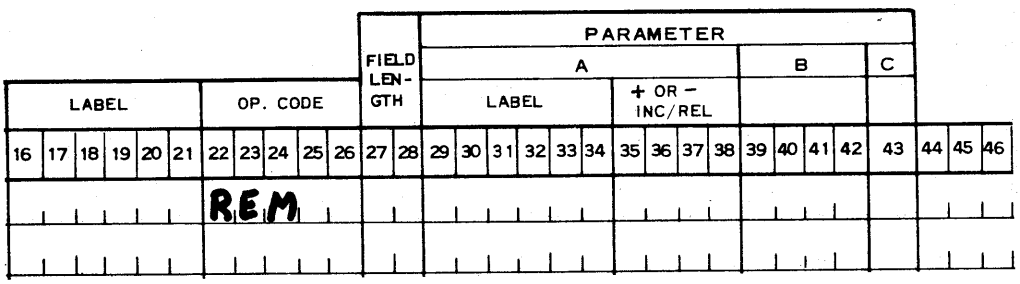


OP CODE	A	B	REMARKS
TRM	AREA		Transfer the contents of Accumulator to memory location addressed by label area.

	OP CODE	A
TRANSFER REMAINDER TO ACCUMULATOR	REM	

The REM instruction transfers the remainder of a division operation to the Accumulator from the control area. The transfer will reset all Accumulator flags.

Example:



SHIFT ACCUMULATOR INSTRUCTIONS

	OP CODE	A	B
SHIFT OFF	SLRO	0-14	0-14

The SLRO instruction first causes the 15 digits of the Accumulator to be shifted left the number of positions specified by the A field. Any non-zero digits shifted off causes the overflow flag to be set. If the digits shifted off are zero, the flag is reset.

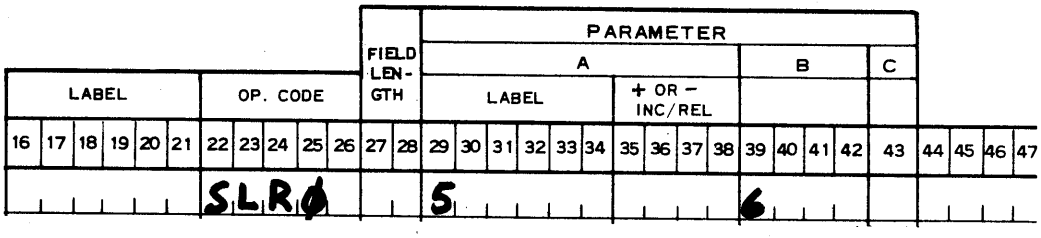
The 15 Accumulator digit positions are then shifted right the number of positions specified by the B field. Any non-zero digit shifted off does not set the overflow flag. Rounding is not performed. The shifted off digits are lost.

Example:

The Accumulator contains

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	ACCUMULATOR DIGIT POSITION
F	1	2	3	4	5	6	7	8	9	8	7	6	5	4	3	VALUE

Examine the results when we execute the following instruction:



OP CODE	A	B
SLRO	5	6

After the 5 in the A parameter is executed the Accumulator contains

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	ACCUMULATOR DIGIT POSITION
F	6	7	8	9	8	7	6	5	4	3	0	0	0	0	0	VALUE

The overflow flag is set.

Then the contents are shifted right

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	ACCUMULATOR DIGIT POSITION
F	0	0	0	0	0	0	6	7	8	9	8	7	6	5	4	VALUE

SHIFT OFF WITH SIGN INSTRUCTION

	OP CODE	A	B
SHIFT OFF WITH SIGN	SLROS	0-15	0-15

The SLROS instruction is the same as the SLRO instruction except that the sign position is also shifted.

This instruction may be used to shift alpha information.

FLAG INSTRUCTIONS

CHANGE FLAGS INSTRUCTION

	OP CODE	A	B
CHANGE FLAGS	CHG	A K X Y R P	1 2 3 4 – S C M

The CHG instruction reverses the condition (set or reset) of selected flags of any one flag group. A set flag is reset, a reset flag is set.

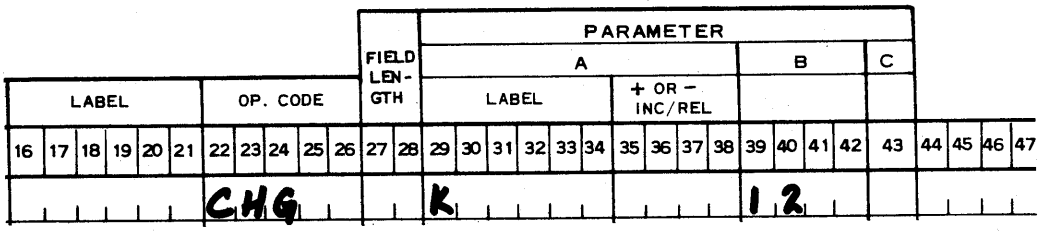
LOD

The flag group is designated in the A field and represented as:

DESIGNATION	FLAG GROUP
A	Accumulator Flags (–, S, C, M)
K	Operation Control Key Flags (1, 2, 3, 4)
X	General Purpose Flags (1, 2, 3, 4)
Y	General Purpose Flags (1, 2, 3, 4)
R	Reader (Paper Tape or Card) Flags (1, 2, 3, 4)
P	Punch (Paper Tape or Card) Flags (1, 2, 3, 4)

The flags to be changed are represented as symbols or numbers in the B field. Any or all of the four flags of a flag group may be changed; all other flags in the group not changed are left unaltered.

Example:

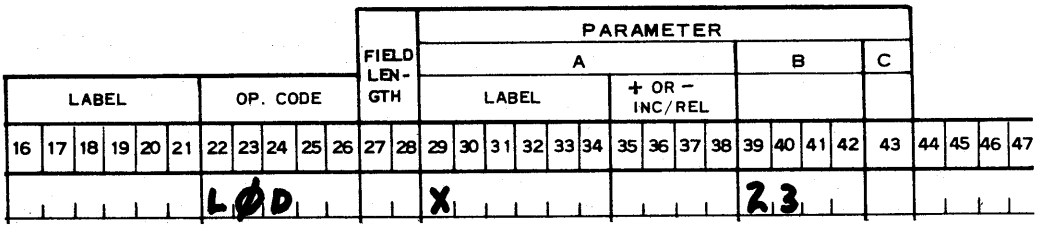


LOAD FLAGS INSTRUCTION

	OP CODE	A	B
LOAD FLAGS	LOD	A K X Y R P	1 2 3 4 – S C M

The LOD instruction provides for setting selected flags of any one flag group. The A field designates the flag group to be set (refer to CHG instruction). The flags to be set are designated by numbers or symbols in the B field. Any or all of the four flags in a group may be set. All other flags in the group not set, are reset.

Example:



OP CODE	A	B	REMARKS
LOD	X	2,3	General purpose (group X) flags 2,3 are set, the other X flags are reset.

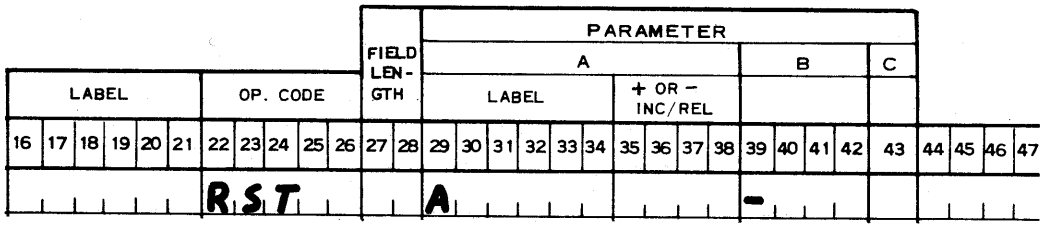
RST
SET

RESET FLAGS INSTRUCTION

	OP CODE	A	B
RESET FLAGS	RST	A K X Y R P	1 2 3 4 – S C M

An RST instruction resets selected flags of any one flag group. The flag group is designated in the A field. (See CHG instructions for flag group designation.) The flags to be reset are specified by numbers or symbols in the B field. Any or all of the four flags may be reset. All other flags not reset are left unaltered.

Example:



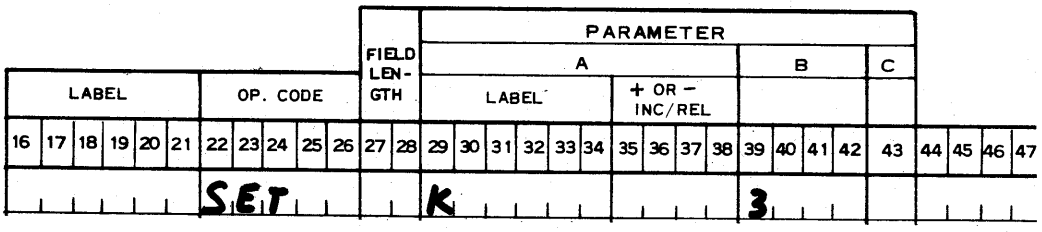
OP CODE	A	B	REMARKS
RST	A	–	The "minus" flag of the Accumulator flag group is reset. ALL others are left unaltered.

SET FLAGS INSTRUCTIONS

	OP CODE	A	B
SET FLAGS	SET	A K X Y R P	1 2 3 4 – S C M

The SET instructions sets selected flags of any one flag group. The flag group is designated in the A field. (Ref. to CHG instruction for flag group and designation.) The flags to be set are designated by number or symbols in the B field. Any or all of the four flags of a group may be set. All other flags in the group not set, are left unaltered.

Example:



OP CODE	A	B	REMARKS
SET	K	3	The OCK flag 3 is set, other flags are unaltered.

ADIR
DIR

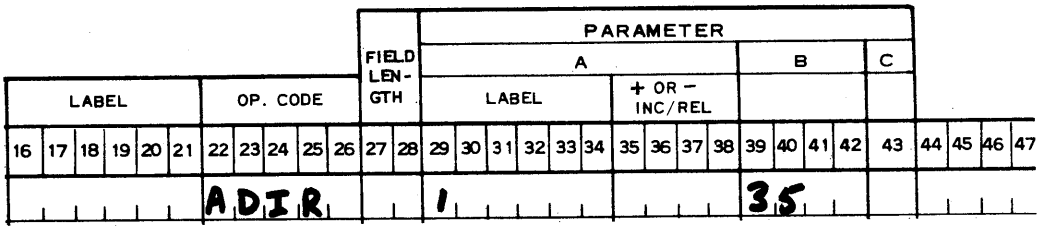
INDEX REGISTER INSTRUCTIONS

ADD TO INDEX REGISTER INSTRUCTION

	OP CODE	A	B
ADD TO INDEX REGISTER	ADIR	1-4	0-255

The number contained in the B field is added to the contents of the index register (1, 2, 3 or 4) indicated by the A parameter. The B field contents and the index register contents are always positive. If the sum of the index register contents and the B field number equal 256, the register is reset to 0. If the sum is greater than 256, only the overflow is retained in the index register. In both cases, the overflow causes the Index Register Flag to be set. If the sum is less than 256, the flag is reset.

Example: Index Register 1 contains 225.



OP CODE	A	B
ADIR	1	35

After execution of the above command, the contents of Index Register 1 is equal to 4 (225 + 35 − 256 = 4). The Index Register Flag is set.

DECREMENT INDEX REGISTER INSTRUCTION

	OP CODE	A	B
DECREMENT INDEX REGISTER	DIR	1-4	0-255

The DIR instruction decreases by 1, the contents of the index register designated by the A field. If the index register contains 0, a decrement causes the value 255 to be entered into the register. The B field designates a value which is compared to the contents of the index register.

If the contents of the index register, designated by the A field, is equal to the value of the B field before decrementing is effected, the Index Register Flag is set after execution. If an unequal condition exists, the flag is reset after execution. Thus, if the flag is set during one decrementing, it will be reset during the next. For that reason, it becomes necessary to test this flag after each decrementing.

The value of the B field does not halt decrementing or turn the register back to 0, once decrementing has reached that limit.

IIR
LIR
TAIR
MOD

INCREMENT INDEX REGISTER INSTRUCTION

	OP CODE	A	B
INCREMENT INDEX REGISTER	IIR	1-4	0-255

The IIR instruction increases by 1, the contents of the index register denoted by the A field. If the index register contains 255, incrementing causes the register to become 0. The B field designates a value which is compared to the contents of the index register.

The Index Register Flag is set and reset as in the DIR instruction.

Example: Use of Index Registers to terminate a loop (see SK instruction).

LOAD INDEX REGISTER INSTRUCTION

	OP CODE	A	B
LOAD INDEX REGISTER	LIR	1-4	0-255

The LIR instruction loads the value contained in the B field into the index register indicated in the A parameter (1, 2, 3 or 4). The B parameter can be any positive value from 0 to 255. The prior contents of the index register are destroyed.

TRANSFER ACCUMULATOR CONTENTS TO INDEX REGISTER

	OP CODE	A	B
TRANSFER ACCUMULATOR TO INDEX REGISTER	TAIR	1-4	

The TAIR instruction transfers the contents of the Accumulator to the register indicated by the A field. The prior contents of that index register are destroyed. The value of the Accumulator is treated as an absolute number, regardless of any "assumed" decimal places during entry in the Accumulator, and regardless of the setting of the Sign Flag.

Since an index register has a capacity of 255, an Accumulator value greater than 255 that is transferred to an index register will be accepted as that amount that exceeds the nearest multiple of 256 (maximum of 1024).

Example:

If the Accumulator contains 258, then 2 is transferred (258 – 256 = 2).

If the Accumulator contains 525, then 13 is transferred (525 – (2 x 256)) = 13).

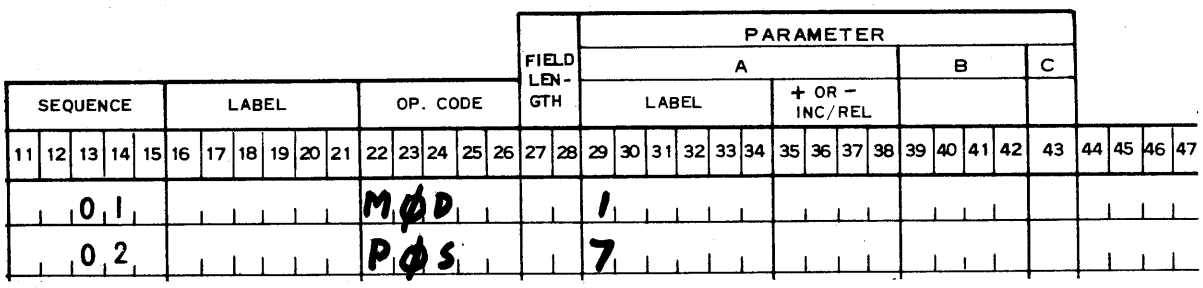
MODIFY BY INDEX REGISTER INSTRUCTION

	OP CODE	A	B
MODIFY BY INDEX REGISTER	MOD	1-4	

The MOD instruction provides for adding the value in the index register designated by the A field to the parameter (or parameters) of the next instruction in program sequence following the MOD instruction. The instruction following MOD is then executed in accordance with the combined parameter values.

The MOD instruction does not change the instruction stored in memory. Modification occurs during the execution of the instruction, as the parameter is extracted from the instruction and placed in a special register. The MOD instruction affects the execution of only the one instruction immediately following.

Example:



Assume Index Register Number 1 contains 50

OP CODE	A
MOD	1
POS	7

The index register value of 50 combined with the value of the A parameter for the POS instruction causes the printer to position to 57 (7 + 50).

Although the MOD instruction is most generally used to modify those instructions which address word locations in memory, it may also be used to modify the parameters of most other instructions. The contents of the index register are added to the parameter field to modulo 256. Modulo 256 means that if the index register (maximum capacity of 256) when added to the parameter field (also a maximum capacity of 256 in machine language), exceeds 256, a "carry" of 1 is generated and the excess value starts back to 0.

Example:

An index register with a value of 150, when added to an AL 200, generates a "carry" of 1 and a remaining parameter of 94 (350 − 256 = 94). The carry is propagated to machine language operation code. Because of this, caution must be used in modifying most instructions since a "carry" may improperly modify the Op Code.

Different types of instructions will have the A parameter, or the B parameter, or both the A and B parameters modified. Some instructions cannot be modified.

Instructions in which only the A Parameter can be Modified

The contents of the index register specified by the MOD instruction are added to the A parameter. If the combined value exceeds the range shown for each instruction parameter, either a "carry" will generate a new instruction, or the instruction will otherwise be improperly modified:

TABLE

Instructions in which only the A parameter is modifiable.

OP CODE	A	OP CODE	A	OP CODE	A
ADA	LABEL*	LRLR	0-255	SUA	LABEL*
ADM	LABEL*	LSR	0-15	SUM	LABEL*
AL	0-255	LXC	0-255 (1)	TAIR	1-4
ALR	0-255	MUL	LABEL*	TK	0-150
ALTO	0-255	MULR	LABEL*	TKM	0-150
AR	0-255	OC	0-255	TRA	LABEL*
ARTO	0-255	PA	LABEL*	TRAB	0-15
BRU	LABEL*	PAB	0-150	TRB	1-15
CLM	LABEL*	PBA	1-16	TRBA	0-16
CPA	LABEL*	POS	1-150	TRCA	1-16
DIV	LABEL*	RCP	1-255	TRCM	1-16
DUP	1-80	REAM	0-150	TRF	0-255
EAM	0-150	RTK	0-150	TRM	LABEL*
IRCP	0-255	RTKM	0-150	TSB	1-15
LCD	0-255	RXEAM	0-150	XA	LABEL*
LCFR	LABEL*	RXTK	0-150	XB	0-255
LKBR	LABEL*	RXTKM	0-150	XBA	1-16
LLCR	0-255	SCP	1-255	XEAM	0-150
LLLR	0-255	SKP	1-80	XMOD	0-255
LPKR	LABEL*	SRJ	LABEL*	XPA	LABEL*
LPNR	LABEL*	SRR	1-4	XPBA	1-16
LRBR	LABEL*			XTK	0-150
LRCR	0-255			XTKM	0-150

*The memory address referenced by the LABEL will be incremented by the value of the index register.

(1) The card punch instruction LXC is not modifiable.

Instructions in which only the B Parameter can be Modified

In the following instructions, only the B parameter field is modified; other parameter fields are unmodified. The contents of the index register is added to the B parameter of the instruction. If the combined value exceeds 255, either a "carry" will create a different instruction, or the instruction will otherwise be improperly modified.

TABLE

Instructions in which only the B parameter can be modified.

OP CODE	A	B
ADIR	1-4	0-255
DIR	1-4	0-255
IIR	1-4	0-255
LIR	1-4	0-255

Instructions in which A and B Parameters can be Modified

A. ONE PARAMETER CAN SPECIFY ONE OR MORE ITEMS. For some instructions the A and B parameters represent a binary pattern to the machine. The PKA, PKB instructions as well as the LOD, SET, RST and CHG flag instructions are programed by listing the digits 1-8 (in the case of the PK instructions) and 1-4 (in the case of the flag instructions) in the A, B or A and B parameters for the desired pattern.

The EX, EXE, SK and SKE instructions are programed by listing the digits 1-4 in the B parameter to designate the particular flag pattern desired.

To modify this binary pattern, it is necessary to find the decimal equivalent of the pattern desired and add it to the Index Register used in the MOD instruction. The value table below may be used to determine the number necessary to obtain the desired pattern.

TABLE

Value Table			
No. in A, B or A & B Fields	Decimal Equivalent		
	PKA PKB A & B field	Flag Instructions	
		B field only	A field
1	1	2	Punch = 0
2	2	4	Read = 16
3	4	8	X = 64
4	8	1	Y = 80
5	16		T = 128
6	32		K = 144
7	64		A = 192
8	128		

For PK's, add together all of the equivalent values for the PK's specified in the A field, to determine the total value which must be loaded in the index register.

For Flag instructions (Set/Reset and Skip/Execute), add together the equivalent values for the flags specified in the B parameter. If the flag group is also to be modified, add its value to the total value for the individual flags, and the resulting sum is the value to be loaded in the index register.

To modify these instructions it is essential to originate them with 0 in the parameter fields and the desired pattern in the index register.

If these instructions are originated with some significant value in the parameter fields, an attempt to modify the parameters can propagate a carry which will be added to the Op Code, changing it to another Op Code.

TABLE

Instructions in which A and B parameters can be modified.

ONE PARAMETER CAN SPECIFY ONE OR MORE ITEMS.

OP CODE	A	B	C
PKA	12345678		
PKB	12345678		
LOD	A K X Y R P	1 2 3 4	
SET	A K X Y R P	1 2 3 4	
RST	A K X Y R P	1 2 3 4	
CHG	A K X Y R P	1 2 3 4	
EX	A T K X Y R P	1 2 3 4	1-4
EXE	A T K X		1-4
SK	A T K X Y R P	1 2 3 4	1-4
SKE	A T K X Y R P	1 2 3 4	1-4

B. EACH PARAMETER CAN SPECIFY ONLY ONE ITEM. In these instructions, either or both, the A or B parameter can be modified. The C parameter, if one exists, is not modified. The A and B parameters combined cannot exceed 256. The sixteen possibilities in the B parameter requires a value from 0 to 15 in the index register for modification. The sixteen possibilities in the A parameter field require a value expressed in multiples of 16 (reflecting the digit position value of the A parameter in the instruction format).

The following table illustrates the proper values to be loaded in the index register to achieve the desired values for the A and B parameters.

TABLE FOR VALUES

Number desired in A field	"m" Value to be contained in Index Reg.	Number desired in B field	"n" Value to be contained in Index Reg.
0	0	0	0
1	16	1	1
2	32	2	2
3	48	3	3
4	64	4	4
5	80	5	5
6	96	6	6
7	112	7	7
8	128	8	8
9	144	9	9
10	160	10	10
11	176	11	11
12	192	12	12
13	208	13	13
14	224	14	14
15	240	15	15
"m" + "n" = total value to be contained in register.			

Example: Modify NK 0 0 to provide 8 whole numbers and 3 decimal fractions:

Parameters required:		Index Register value required:
A = 8	=	128
B = 3	=	3
		131 (total value)

Thus:

LIR 1		131
MOD 1		
NK 0		0

The index register value of 131 modifies the NK instruction to permit 8 whole numbers and 3 fractions.

Any time that the modification of the B parameter results in a carry (exceeds 15), the carry will add to the A parameter changing its specification. A carry resulting from modification of the A parameter (exceeds 255) will add to the Op Code causing an improper modification.

EACH PARAMETER CAN SPECIFY ONLY ONE ITEM

OP CODE	A	B	C	OP CODE	A	B
ADK	0-14	0-9		PN	0-14	0-15
CLA	0-15	0-9		PNS+	0-14	0-15
EXL	0-15	0-15	1-4	PNS–	0-14	0-15
INK	0-14	0-9		TRCB	0-15	0-15
NK	0-15	0-15		XC	0-15	0-15
NKCM	0-15	0-15		XN	0-14	0-15
NKR	0-15	0-15		XPN	0-14	0-15
NKRCM	0-15	0-15		XPNS+	0-14	0-15
SKL	0-15	0-15	1-4	XPNS–	0-14	0-15
SLRO	0-14	0-14				
SLROS	0-15	0-15				
SUK	0-14	0-9				
RNK	0-15	0-15				

UNMODIFIABLE INSTRUCTIONS

The following instructions cannot be modified:

TABLE

Instructions which are not modifiable.

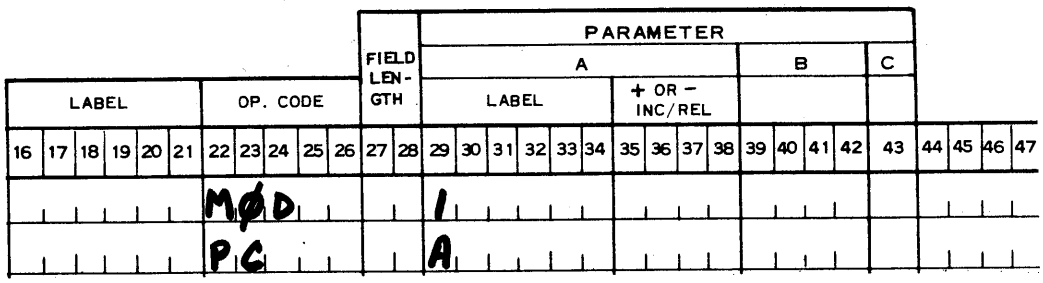
OP CODE	A	OP CODE	A	OP CODE	A
ALARM		LSN		RPR	
ALTP		LTN		RR	
CC		LXC	1	RRA	
EXZ	1-4	NOP		RSA	
LPF		RCD		RSN	
LPR		REL		RTH	
LRA		REM		RTN	
LSA		RPF		SKZ	1-4
				STOP	

MODIFICATION OF PRINT CHARACTER

The character in the A parameter of a PC instruction may be modified to obtain a different character. The MOD instruction will add the contents of the index register to the internal code of the character in the A parameter of the PC instruction.

BRU

Example:



OP CODE	A
MOD	1
PC	A

If PC A (A = index value of 65) is to be modified to print M (M = index value of 77), a value of 12 (77-65 = 12) is loaded into the index register #1. Index values are contained in Appendix D. The above remarks also apply to PC+, PC– and PCP.

MODIFICATION OF A MODIFY INSTRUCTION

A MOD instruction may be used to modify another modify instruction with the same or different index register. The total amount of modification equals the sum of the MOD instructions, and should not exceed 255. When the total exceeds 255, only the difference between the total and 255 remains in the index register.

BRANCH AND DECISION INSTRUCTIONS

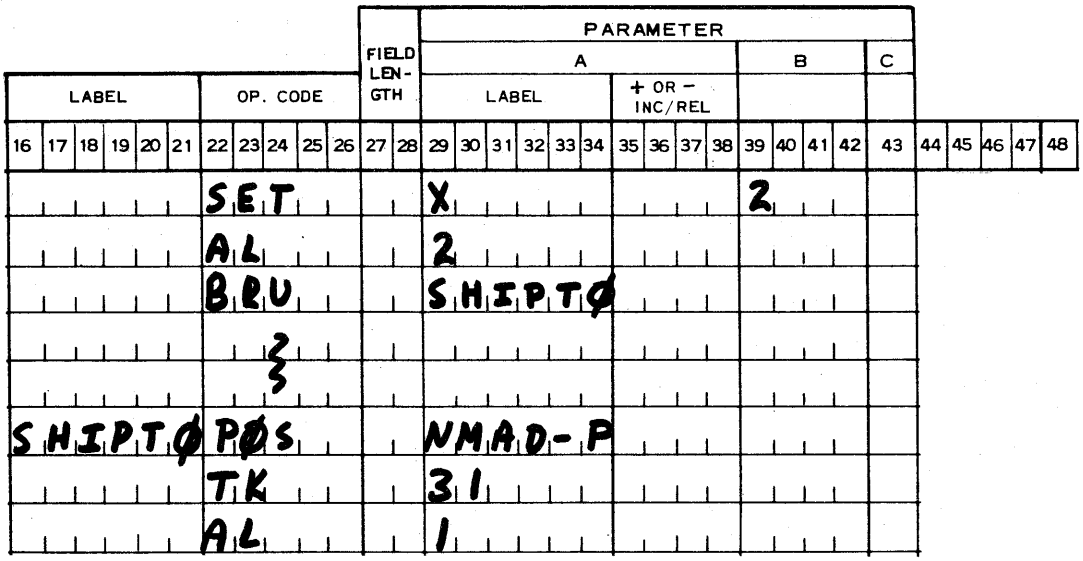
BRANCH UNCONDITIONAL INSTRUCTIONS

	OP CODE	A	+/– REL
BRANCH UNCONDITIONAL	BRU	LABEL	$\pm$ N

The BRU instruction provides the ability to branch unconditionally to a different segment of the program. This instruction does not automatically provide for return to the branched from segment of the program.

The A parameter contains the label which identifies the memory address to where the program will branch. The A parameter can be incremented by an integer (N, positive or negative) located in the +/– REL field.

Example:



When the BRU instruction is executed program execution continues with the Op Code contained in the memory location referenced by the label. In this case the label is SHIPTO and the Op Code is POS.

SUBROUTINE JUMP AND RETURN INSTRUCTIONS

	OP CODE	A	+/− INC
SUBROUTINE JUMP	SRJ	LABEL	+ N −
SUBROUTINE RETURN	SRR	1-4	

The SRJ and SRR instruction facilitate branching to, and returning from a subroutine. The A parameter of the SRJ instruction contains the label of the memory location to where the jump will occur. The A parameter can be +/− incremented from 1 to 255.

The SRJ and SRR instructions utilize the Subroutine Return Stack which appears thusly:

LOCATION	ADDRESS
1	MEMORY LOCATION
2	MEMORY LOCATION
3	MEMORY LOCATION
4	MEMORY LOCATION

This example illustrates the use of these instructions and explains the A parameter of the SRR instruction.

WORD	SYLLABLE	LABEL	OP CODE	A	B	REMARKS
25	0		NKR	10	4	Allow Numeric Entry.
	1		AL	1		Advance 1 line.
	2		POS	63		Position to print.
	3		SRJ	PRNC		SRT to print.
	?		?	?		
48	0	PRNC	PNS–	14	0	
	1		PC–	–		
	2		PC+	+		
	3		SRJ	TKMAD		
	?		?	?		
50	0	TKMAD	POS	95		Positions for type.
	1		TK	31		Type 31 characters.
	2		SRR	1		Subroutine return.
	3					

When the SRJ instruction in word 25 syllable 3 is executed, the program counter is increased by 1 syllable. The new program counter content, word 26 syllable 0 is stored in Subroutine Return Stack location 1. The value of the A parameter in the SRJ instruction is inserted in the program, execution now begins at word 48, syllable 0. The Subroutine Return Stack would appear:

LOCATION	ADDRESS
1	26 0
2	UNKNOWN-1
3	UNKNOWN-2
4	UNKNOWN-3

When the SRJ instruction in word 48, syllable 3 is reached, the contents of the Return Stack are shifted down 1 location. The memory address in location 4 is lost. Execution continues in word 50 syllable 0. The stack now contains:

LOCATION	ADDRESS
1	49 0
2	26 0
3	UNKNOWN-1
4	UNKNOWN-2

If the process is repeated 5 times, the original address entered (word 25 syllable 3) is lost from program control. Each additional repetition loses another memory address. It is recommended to limit the nesting of subroutines to 4.

The execution of the SRR instruction in word 50 syllable 2 will cause the program counter to be loaded with a value from the Subroutine Return Stack. The value loaded is a function of the A parameter for the SRR instruction.

If the A value is 1, the memory address in location 1 is inserted in the program counter. A value of 2 would select location 2. A value of 3 would select location 3. A value of 4 would select the fourth location.

Since in our example we have a value of 1, word 49, syllable 0 is inserted into the program counter. Program execution begins with that value. The Return Stack would appear:

LOCATION	ADDRESS
1	26 0
2	UNKNOWN-1
3	UNKNOWN-2
4	UNKNOWN-4

If the A value had been 2, word 26, syllable 0 would have been inserted in the program counter. All addresses with location numbers less than the selected location are lost. The remaining values are pushed to the top of the stack.

In this case the Subroutine Return Stack would appear:

LOCATION	ADDRESS
1	UNKNOWN-1
2	UNKNOWN-2
3	UNKNOWN-4
4	UNKNOWN-5

Program execution begins at word 26, syllable 0.

COMPARE ALPHANUMERIC INSTRUCTION

	OP CODE	A
COMPARE ALPHANUMERIC	CPA	LABEL

The CPA instruction compares the contents of the memory word, referenced by the label contained in the "A" field, to the contents of the Accumulator. The outcome:

1. Execute the next instruction if contents are equal.
2. Execute second if memory word content is less than Accumulator content. Skip the first in sequence and begin execution.
3. If memory location content is greater than the Accumulator content, skip the first two in sequence and execute the third.

Refer to Appendix for collating sequence of character set.

EXZ
SKZ

Example:

LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
MAX	NK		4		0	
	CPA		TEST			
	NOP					
	BRU			+ 2		
	BRU			+ 3		
	ALARM					
	BRU		MAX			

This routine will allow the operator to index a value less than the value contained in the memory location TEST.

SKIP AND EXECUTE INSTRUCTIONS

Accumulator Skip and Execute Instructions

	OP CODE	A
EXECUTE IF ACCUMULATOR ZERO	EXZ	1-4

If the content of the Accumulator is zero, the EXZ instruction will cause the next instruction to be executed. If it is not zero, the next "A" instructions will be skipped.

	OP CODE	A
SKIP IF ACCUMULATOR ZERO	SKZ	1-4

The SKZ instruction will cause the next 1-4 instructions (as specified in the "A" field) to be skipped when the Accumulator content is zero. Otherwise, the next instruction is executed.

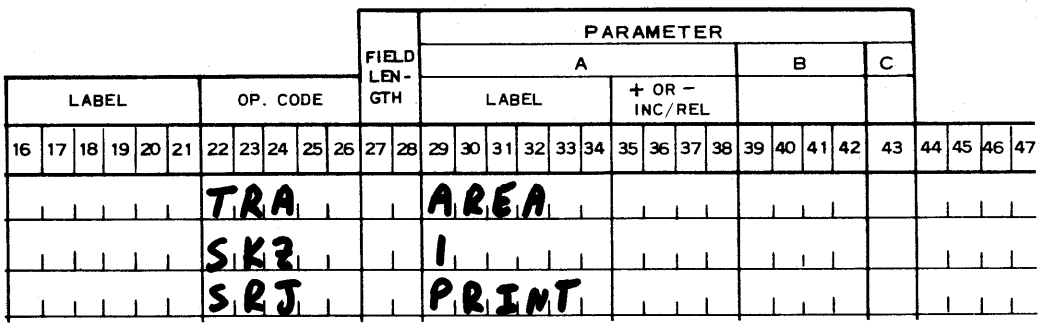
Example: Routine to enforce a non-zero keyboard listing

LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
NUMRIC	NK		5		1	
	EXZ		1			
	BRU		NUMRIC			
	PNS-		5		0	

LABEL	OP CODE	A	B	REMARKS
NUMRIC	NK	5	1	Enable numeric keyboard.
	EXZ	1		Execute 1 instruction if
		NUMRIC		Accumulator zero.
	BRU	5		Branch to numeric keyboard.
	PNS-		0	Print shift ribbon (-).

If an OCK is depressed without a numeric keyboard entry, the Accumulator contains zero. In the above example, whenever the Accumulator contains zero the BRU instruction is executed and the program branches to the NK command. This occurs until a numeric keyboard listing is made and the Accumulator is not zero; the BRU instruction is then skipped.

Example: Do not print if the Accumulator is zero.



OP CODE	A	B	REMARKS
TRA	AREA		Transfer to Accumulator.
SKZ	1		Skip 1 instruction if zero.
SRJ	PRINT		Branch to print routine.

If Accumulator Digit less than Constant, Execute Instruction

	OP CODE	A	B	C
EXECUTE IF DIGIT LESS THAN CONSTANT	EXL	0-15	0-15	1-4

The EXL instruction causes the next instruction to be executed if the digit in the Accumulator digit position specified in the "A" field is less than the constant contained in the "B" field, otherwise the next "C" are skipped. The Accumulator is undisturbed.

If Accumulator Digit less than Constant, Skip Instruction

	OP CODE	A	B	C
SKIP IF DIGIT LESS THAN CONSTANT	SKL	0-15	0-15	1-4

The SKL instruction causes the next 1-4 instruction (as specified by the "C" field) to be skipped if the digit in the Accumulator digit position specified in the "A" parameter is less than the constant contained in the "B" field. Otherwise, the next instruction is executed. The Accumulator is undisturbed.

EX

FLAG EXECUTE AND SKIP INSTRUCTIONS

Execute Flag Instructions

	OP CODE	A	B	C
EXECUTE IF ANY FLAG	EX	A T K X Y R P	O L I U 1 2 3 4 – S C M	1-4

The EX instruction causes the next instruction in sequence to be executed if any of the flags specified in the "B" field (of the flag group designated in "A" field) are set. Otherwise, the next "C" instructions are skipped. (See SK instruction for flags and flag groups.)

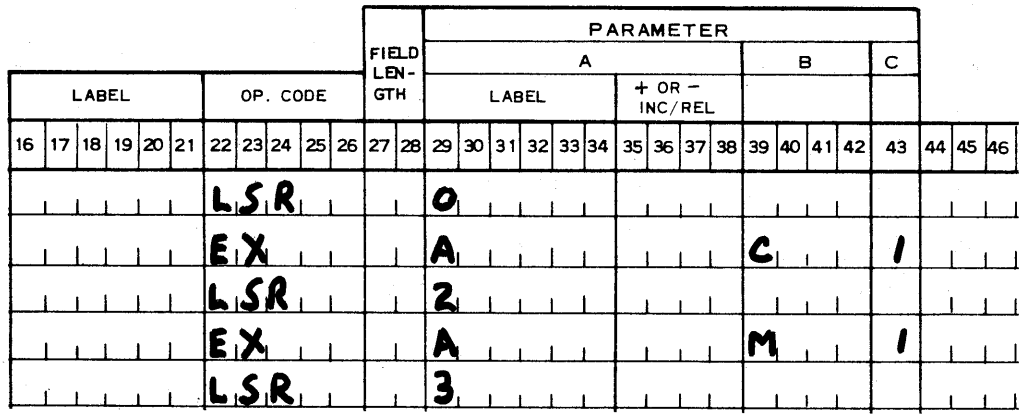
Example: Use of OCK to choose alternate branch of program

			PARAMETER			
		FIELD LEN-GTH	A		B	C
LABEL	OP. CODE		LABEL	+ OR – INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	LKBR		TYPE			
	TKM		25			
	EX		K		1 2	1
	BRU		START			
	PA		TYPE			

OP CODE	A	B	C	REMARKS
LKBR	TYPE			Load Base Register.
TKM	25			Type into memory.
EX	K	1 2	1	Execute 1 if OCK 1, 2
BRU	START			Branch
PA	TYPE			

In the above example the program will branch if OCK 1 or 2 was used. OCK 3 or 4 would cause a print.

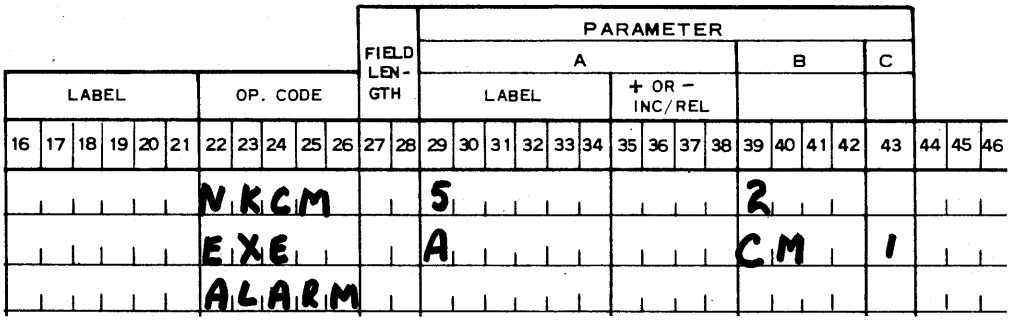
Example: Load the Shift Register with 2 if the C key is used and with 3 if the M key is used:



OP CODE	A	B	C	REMARKS
LSR	0			Test if "C" key used.
EX	A	C	1	Load shift register with 2.
LSR	2			Test if "M" key used.
EX	A	M	1	Load shift register with 3.
LSR	3			

	OP CODE	A	B	C
EXECUTE IF EVERY FLAGS	EXE	A T K X Y R P	O C I U 1 2 3 4 − S C M	1-4

The EXE instruction causes the next instruction to be executed if all the flags specified in the "B" field (of flag group designated by the "A" field) are set. Otherwise, the next "C" instructions are skipped.



If the operator indexes both C and M keys, the alarm will sound.

Skip Flag Instructions

	OP CODE	A	B	C
SKIP IF ANY FLAGS	SK	A T K X Y R P	O L I U 1 2 3 4 − S C M	1-4

The SK instruction causes the next "C" instructions (1-4) to be skipped if any of the flags specified in the "B" field, (flag group specified in "A" field) are set. Otherwise, the next instruction is executed. The flags and flag groups are designated thusly:

FLAG	SYMBOL
Group A - Accumulator Flags	
Sign	—
Special	S
Per hundred (C)	C
Per thousand (M)	M
Group T - Test Flags	
Accumulator Overflow	O
Forms Limit	L
Index Register	I
Unassigned	U
Group K - Operator Control Keys Flags	1 2 3 4
Group X - General Purpose X Flags	1 2 3 4
Group Y - General Purpose Y Flags	1 2 3 4
Group R - Reader Flags	1 2 3 4
Group P - Punch Flags	1 2 3 4

Example: To terminate a loop

		FIELD LEN-GTH	PARAMETER			
			A		B	C
LABEL	OP. CODE		LABEL	+ OR − INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
NUMRIC	LIR		1		0	
	NK		2		3	
	PØS		121			
	AL		3			
	PN		4		0	
	IIR		1		4	
	SK		T		I	1
	BRU		NUMRIC			

SKE
ALARM
NOP
STOP

LABEL	OP CODE	A	B	C	REMARKS
NUMRIC	LIR	1	0		Load Index Register.
	NK	2	3		Enable numeric keyboard.
	POS	1 2 1			Position printer.
	AL	3			Advance 3 lines.
	PN	4	0		
	IIR	1	4		Increment Index Register.
	SK	T	I	1	Skip 1 instruction if T set.
	BRU	NUMRIC			Branch to NUMRIC.

	OP CODE	A	B	C
SKIP IF EVERY FLAGS	SKE	A T K X Y R P	O L I U 1 2 3 4 – S C M	1-4

The SKE instruction will cause the next "C" instructions to be skipped if all the flags specified in the "B" field (of the flag group specified) are set. Otherwise, the next instruction is executed.

MISCELLANEOUS INSTRUCTIONS

ALARM INSTRUCTION

	OP CODE
ALARM	ALARM

The ALARM instruction will sound the Error Alarm once. The system does not go into the error state.

Example: Notify operator an error has been made. See the EXE instruction.

NO OPERATION INSTRUCTION

	OP CODE
NO OPERATION	NOP

The NOP instruction performs no operation, but 10 milliseconds are expended when this instruction is used. Program execution continues, sequentially, uninterrupted.

STOP PROGRAM INSTRUCTION

	OP CODE
STOP	STOP

The STOP instruction halts the execution of a program and returns the computer to the Ready Mode.

CDC

(CD)

CHECK DIGIT INSTRUCTIONS

Macro instructions to compute and verify check digits are available for use on the L/TC by incorporating a CDC-CDV Add-On Firmware Set with the Basic Main Memory Firmware Set being utilized. CDC-CDV Add-On Firmware Sets occupy the highest track of user memory provided by the main memory firmware set.

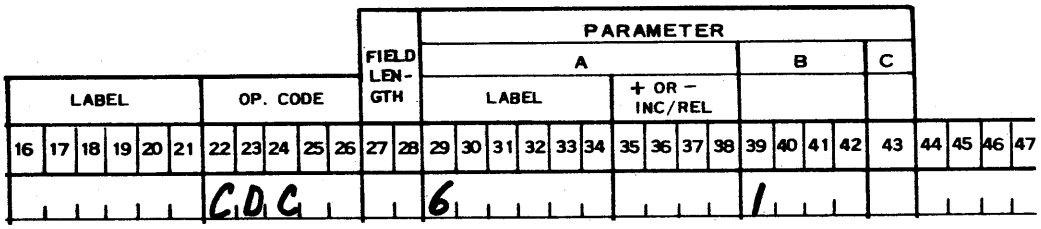
CHECK DIGIT COMPUTE INSTRUCTION

	OP CODE	A	B
CHECK DIGIT COMPUTE	CDC	1-15	0-9

The CDC instruction, when used in conjunction with a check digit table, will generate a check digit for a number located in the Accumulator. The check digit will be generated for the number which begins in the Accumulator digit position indicated by the A parameter and ending in Accumulator digit position 1. The generated check digit will be inserted in Accumulator digit position 0, remaining Accumulator digit positions are not disturbed.

The B parameter specifies the constant remainder that is to be used when computing the check digit.

Example:



OP CODE	A	B
CDC	6	1

If the Accumulator contains:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
F	6	9	8	4	2	9	6	3	8	4	2	9	6	3	0

the check digit will be calculated for the number beginning in Accumulator digit position 6 and ending in Accumulator digit position 1; in this case 842963.

The remainder factor used will be 1.

Example:

LABEL	OP CODE	A	B	C	REMARKS
INITIL	LPNR	TABLE			LOAD CD & P MASK TABLE
	TRA	BAL			RD NEW BALANCE
	SLRO	1	0		POSITION FOR DC
	EX	A	–	1	TEST IF MINUS BALANCE
	CDC	8	3		COMPUTE CD ON MINUS USING REM 3
	SK	A	–	1	SKIP IF MINUS BALANCE
	CDC	8	2		COMPUTE CD ON PLUS USING REM 2
	PNS–	8	2		PRINT NEW BALANCE
	PNS–	0	3		PRINT CHECK DIGIT
	NOTE				ALTERNATE COL DOUBLE ADD DOUBLE
	NOTE				MOD 10 CD TABLE & P MASKS
TABLE	NUM	166009753186420			1ST WORD CD TABLE
	NUM	066009876543210			LAST WORD CD TABLE
	MASK	ZZZ,ZZZ,DDE			P MASK BALANCE
	MASK	+.D			P MASK CHECK DIGIT

CHECK DIGIT VERIFY INSTRUCTION

	OP CODE	A	B
CHECK DIGIT VERIFY	CDV	1-15	0-9

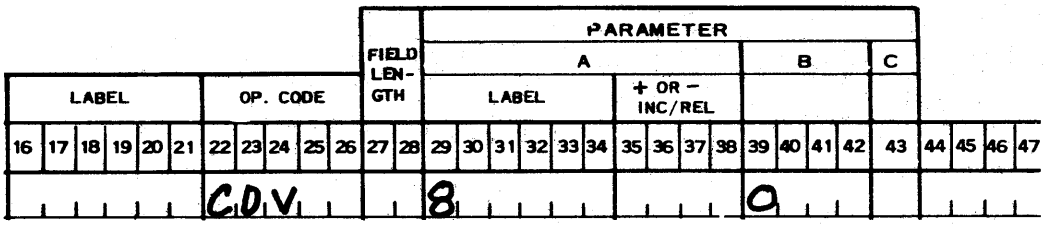
The CDV instruction will verify the check digit of a number located in the Accumulator. The number begins in the Accumulator digit position specified by the A parameter and ends in Accumulator digit position 1. Any significant digits located to the left of the Accumulator digit position specified by the A parameter are ignored by the CDV instruction.

The check digit must be located in Accumulator digit position 0.

The B parameter specifies the constant remainder that is used in computing the check digit. If the check digit is not equal to the computed check digit, the Accumulator S Flag is set and a Keyboard Error Condition occurs at the next keyboard instruction. The programmer should provide the required instructions to check the S Flag after verification.

The checking method is determined by the table designated in the A parameter of the last executed LPNR instruction.

Example:



OP CODE	A	B
CDV	8	0

If the Accumulator contains:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
F	0	0	0	0	0	0	2	3	5	6	8	9	2	4	5

the number to be verified begins in Accumulator digit position 8 and ends in Accumulator digit position 1, in this case 23568924.

The remainder factor is 0. The check digit is 5.

Example: The CDV Instruction in conjunction with a Modulus 11 weighted system could be utilized in the user program in the following manner.

LABEL	OP CODE	A	B	C	REMARKS
INITIL	LPNR	TABLE			LOAD CD & P MASK TABLE
ACCTNO	NKCM	7	0		INDEX ACCT NO. & CHECK DIGIT
	NOTE				USE "C" FOR C.D. VALUE OF "A."
	EX	A	C	2	TEST FOR "A"
	SLRO	1	0		POSITION NUMBER
	INK	0	A		INSERT CHK DIGIT "A"
	CDV	6	0		VERIFY
	EX	A	S	2	EX IF NOT VERIFIED
	BRU	ACCTNO	1		BR TO REINDEX
	PN	6			PRINT ACCT NO.
	NOTE				1, 3, 7 MODULUS 11 CHK DIGIT
	NOTE				TABLE AND PRINT MASKS
TABLE	NUM	355003692581470			WT. 7 VALUES 1ST WORD CD TABLE
	MASK	+DDDDDD,D			ACCT. NO. PRINT MASK
	MASK	ZZZ,ZZZ.DD			AMOUNT PRINT MASK
	NUM	455007418529630			WT. 3 VALUES 2ND WORD CD TABLE
	NUM	055009876543210			WT. 1 VALUES 3RD WORD CD TABLE

LOAD CHECK DIGIT AND PRINT NUMERIC TABLE INSTRUCTION

	OP CODE	A
LOAD CHECK DIGIT AND PRINT NUMERIC TABLE	LPNR	LABEL

The LPNR instruction is used to locate the check digit and print mask tables when check digit firmware is used. The first entry of the table must be a check digit entry. The table can vary in size from 2 to 256 words. The reader should reference CHECK DIGIT TABLE CONSTRUCTION.

CHECK DIGIT TABLE CONSTRUCTION

The table(s) that are utilized by the CDC-CDV instruction determine the checking method to be used. The table(s) can be located anywhere within user memory and are referenced by the A Parameter of the LPNR instruction. The table can vary in size from 2 words to 256 words and the individual entries within the table do not have to be stored in consecutive order. However, the first entry in the table must be labeled so that it can be referenced by the LPNR instruction.

Each entry (word) in the table is divided into three sections. These divisions are as follows:

1. Location of the next table entry to be referenced (digit positions 15 & 14).
2. Modulus used (digit positions 13 & 12).
3. Digit values (digit positions 0-9).

Location

The CDC & CDV instructions start with the table entry specified by LPNR. The location of the next table entry to be referenced by the CDC or CDV instruction is determined by the Hexadecimal value of digit positions 15 & 14 of the table entry. This location is relative to the base word of the table (the beginning word of the table which is referenced by the A parameter of the LPNR instruction).

Example:

HEXADECIMAL VALUE IN 15 & 14		RELATIVE LOCATION OF NEXT TABLE ENTRY
0	1	Base Word + 1
0	2	Base Word + 2
1	1	Base Word + 17
0	0	Base Word + 0

Modulus

Digit positions 13 & 12 specify the modulus to be used in the verification scheme. The values in both digit positions within the word must be identical and the value in positions 13 & 12 in each table entry must be identical. The table assumes a base modulus of 16.

Therefore, to determine the entry for positions 13 & 12 the decimal values of the modulus desired must be subtracted from the base modulus of 16. For example, if a modulus 10 scheme is to be used a 6 would be entered in digit positions 13 & 12 of every table entry (16-10 = 6).

Digit Values

Each digit position of an integer (to be checked/computed) has 10 possible values (0 to 9). Each table entry word represents certain digit positions in the integer.

Example: A table with 3 entries (words) is used to check/compute a check digit for a 6-digit integer.

The 1st table entry is used for digits 1 and 4.

The 2nd table entry is used for digits 2 and 5.

The 3rd table entry is used for digits 3 and 6.

The Digit Values section of each table entry contains the weighted or assigned values for the digit positions that the table entry represents. The weighted or assigned values are located within the digit values section (Digit Positions 0-9) in order according to the possible value that it represents. For example, the weighted or assigned values for the possible digit position value of 7 on the integer is stored in digit position 7 of the table entry.

A simple alternate column Double-Add-Double Check Digit scheme would require a two-word table with the following values in digit positions 0-9 (Digit Values Section) of the table entries.

Integer Digit Value and Table Entry Digit Position	9	8	7	6	5	4	3	2	1	0
1st Table Entry Values	9	7	5	3	1	8	6	4	2	0
2nd Table Entry Values	9	8	7	6	5	4	3	2	1	0

Examples:

1. Alternate Column, Double-Add-Double

Modulus 10								
Remainder 0								
Integer (Acct No.)	4	3	2	2	5	7		
Assigned Values From Table	4	+6	+2	+4	+5	+5	=	26
Remainder						0		
Total Sum of Assigned Values						26+0	=	26
Next High Multiple Of Modulus (10)						30		
Check Digit						30–26	=	4

The values assigned in computing the check digit for the above integer (Acct No.) are as follows: The assigned values for the digits located in positions 1, 3 & 5 of the integer are taken from the 1st table entry. The assigned values for the digits located in positions 2, 4 & 6 of the integer are taken from the 2nd table entry.

COMPLETE TABLE

	POSITIONS															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Next Word LOC		Mod				Digit Values									
TABLE ENTRY 1	0	1	6	6			9	7	5	3	1	8	6	4	2	0
TABLE ENTRY 2	0	0	6	6			9	8	7	6	5	4	3	2	1	0

2. 1, 3, 7 MODULUS 11 METHOD

In this method the assigned value for each digit is obtained by assigning weights of 7, 3, 1, 7, 3, 1, . . . continuously; starting with the least significant digit of the number. A three-word table is required.

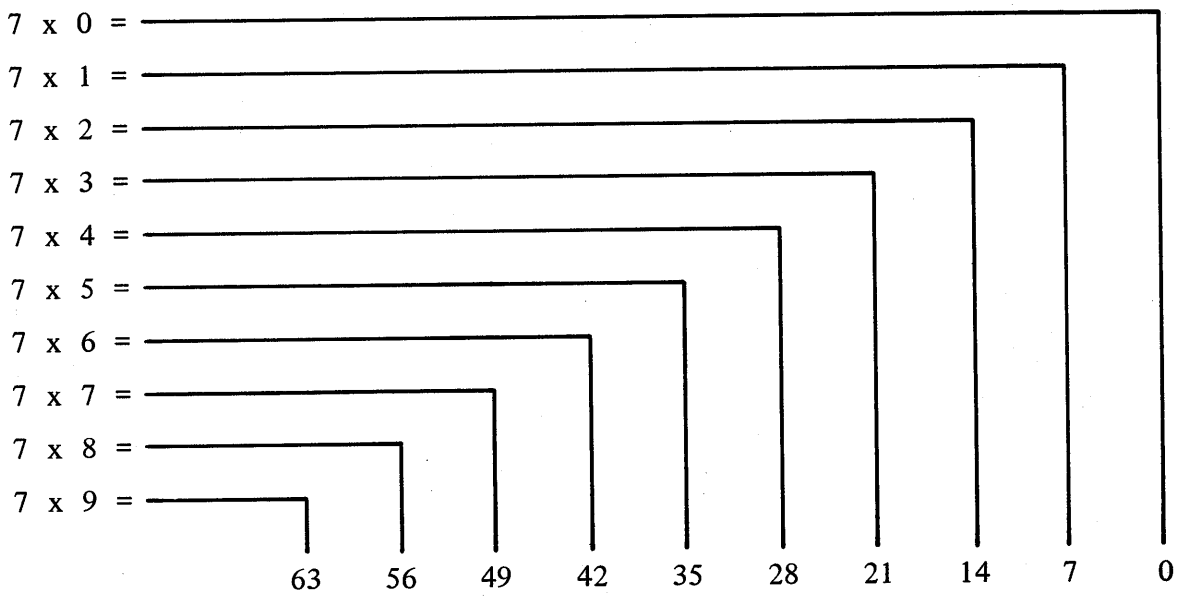
Integer	4 3 2 2 7 7
Assigned Value From Table	4 + 9 + 3 + 2 + A + 5 = 33
Remainder	1
Total Sum of Assigned Values	33 + 1 = 34
Next Higher Multiple of Modulus	44
Check Digit	44–34 = A

TABLE

POSITIONS																
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Next Word LOC		Mod				Digit Values									
0	1	5	5			8	1	5	9	2	6	A	3	7	0
0	2	5	5			5	2	A	7	4	1	9	6	3	0
0	0	5	5			9	8	7	6	5	4	3	2	1	0

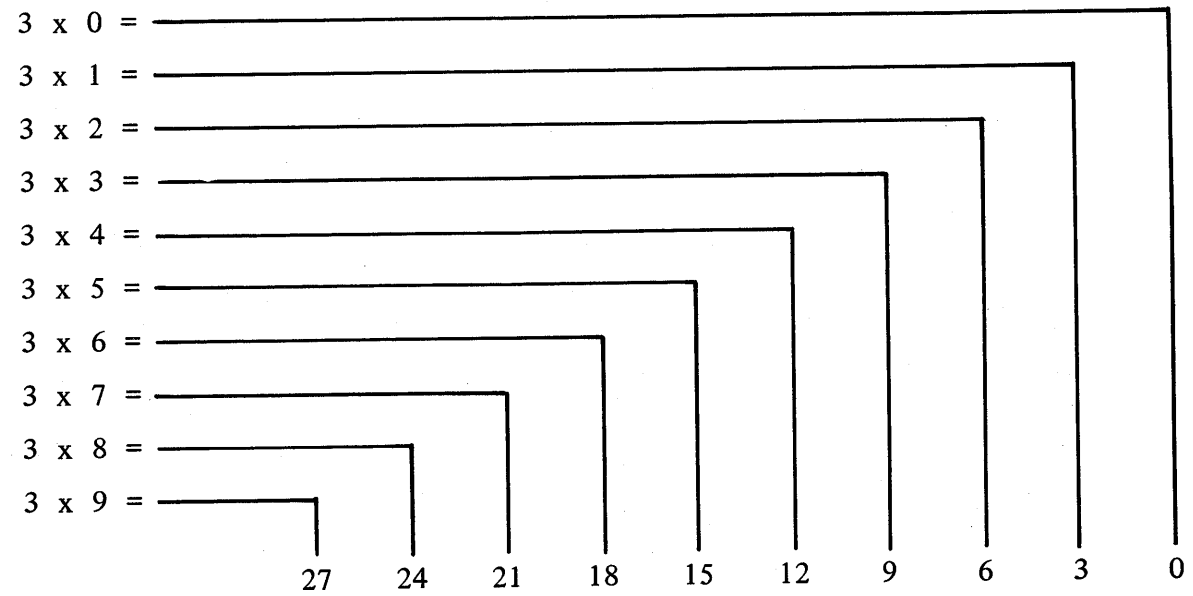
The table for the example of the 1, 3, 7 Modulus 11 Method was derived in the following manner.

1st Table Entry (Weighted 7).



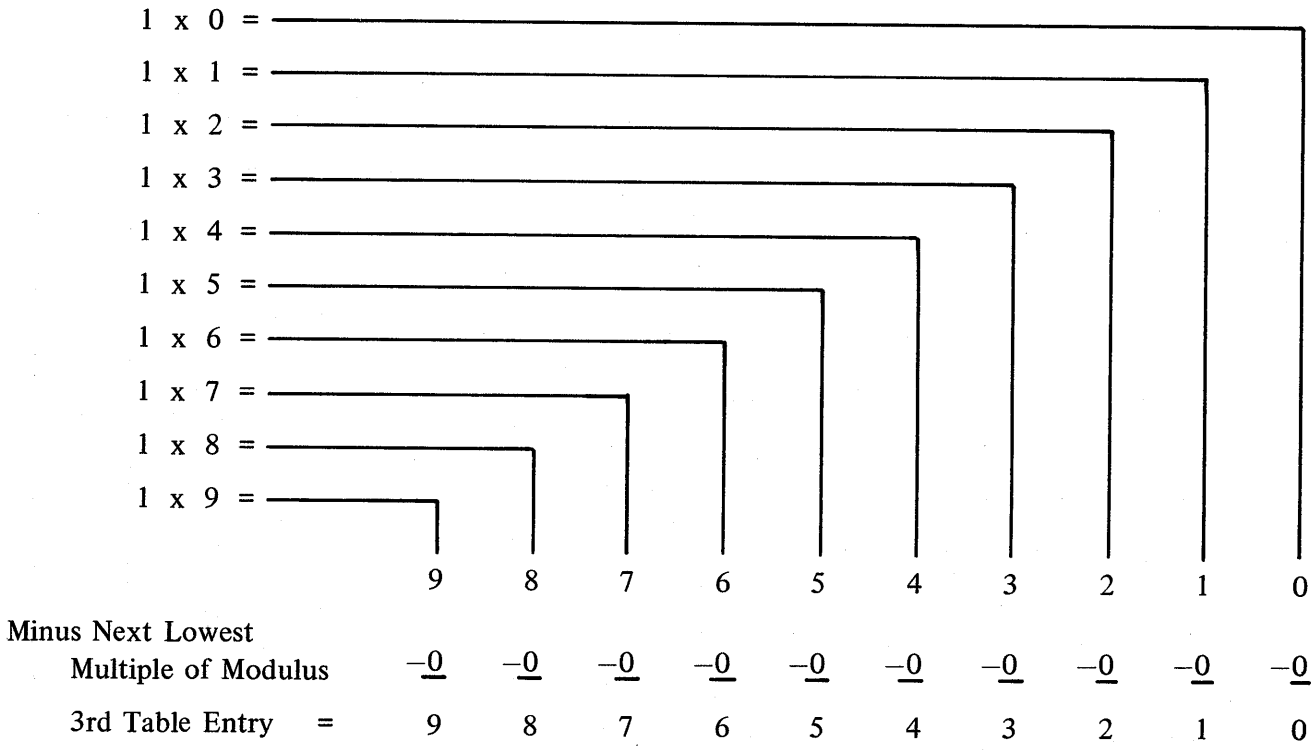
Minus Next Lowest Multiple of Modulus		−55	−55	−44	−33	−33	−22	−11	−11	−0	−0
1st Table Entry	=	8	1	5	9	2	6	A	3	7	0

2nd Table Entry (Weighted 3).



Minus Next Lowest Multiple of Modulus		−22	−22	−11	−11	−11	−11	−0	−0	−0	−0
2nd Table Entry	=	5	2	A	7	4	1	9	6	3	0

3rd Table Entry (Weighted 1).



CDC & CDV of Alphanumeric Fields

A check digit can be accurately computed and verified on fixed length alphanumeric fields that do not exceed 7 characters in length. The check digit would make the 8th character.

Example:

The following example illustrates how a check digit could be computed on a 5-character fixed length alpha field (check digit is entered as the 6th character) using a 1, 3, 7 Modulus 10 Method.

SEQ	LABEL	OP CODE	A	B	C	REMARKS
1	INITAL	LPNR	TABLE			LOAD CHECK DIGIT TABLE
2	CMPCD	POS	10			POSITION PRINTER
3		LKBR	PARTNO			SET KB BASE REGISTER
4		TKM	5			ENTER PART NUMBER
5		TRA	PARTNO			READ ALPHA TO ACCUMULATOR
6		SLROS	0	4		RIGHT JUSTIFY ALPHA NUMBER
7		INK	1	3		INSERT 3 COL 1
8		NOTE				THE 3 IS INSERTED SO THAT THE CD
9		NOTE				NUMBER CAN BE ENTERED THROUGH
10		NOTE				THE ALPHA KEYBOARD AS A COL 3
10.1		NOTE				USASCII NUMERAL.
11		ADK	0	0		DECIMAL CORRECT ALPHA

DATA COMMUNICATIONS INSTRUCTIONS

Recognizing and responding to Polls and Selections from the data center, and the control of transmission of messages from the TC 500 and the receipt of messages directed to the TC 500 are automatic functions of the Data Communication Processor firmware. The user program in the TC 500 is responsible for the preparation of messages to be sent to the data center and for the use of any message data that has been received from the data center.

The Data Communication Processor memory has two buffers of 256 characters capacity each; one is the Receive Buffer, the other is the Transmit (Send) Buffer. Associated with each buffer is a flag and indicator light:

	RECEIVE	SEND
Flag:	R2	R3
Indicator:	Input Light 3	Input Light 4
Set by:	Firmware	User Program
Reset by:	User Program	Firmware

The user program seldom sets the Message Received flag – in an on-line environment, that job belongs to firmware. Conversely, the user program seldom RESETS the Transmit Ready flag. It is possible, however, for the macro instruction RST to turn off the Transmit Ready flag, and it is possible for the macro instruction SET to turn on the Message Received flag. However, these situations seldom arise and the following rule is reliable: the user program SETS the Transmit Ready flag and RESETS the Message Received flag.

All messages are received from the data center into the Receive buffer, and all messages are transmitted to the data center from the Transmit buffer. When a message has been received, the user program must provide for transferring the message data from the Receive buffer into the Accumulator and/or Normal memory for printing, accumulation, processing, etc. When a message is to be transmitted, the user program must provide for transferring the message data from Normal memory and/or from the keyboard into the Transmit buffer. The Receive and Transmit instructions covered in this section permit the transfer of an entire Receive or Transmit buffer to or from the Data Communication Processor memory, or permit the message to be broken apart or assembled in small sections directly in the Data Communication memory. The frequency of transmissions and the availability of Normal memory will determine which method should be used.

The TC 500 Data Communication processor may be in both a Receive Ready state and a Transmit Ready state simultaneously, and responds to whichever (Select or Poll) occurs first; upon responding to the first occurrence, it is then immediately ready to respond to the second, and in the meantime, the user program in Normal memory may proceed with other work.

RECEIVE READY STATE

The TC 500 is placed in a Receive Ready State by programing a RESET instruction to reset the Message Receive Flag (Reader flag 2). This indicates to the Data Communication processor that the user program has finished with the last message received, and thus, the Receive buffer may accept another message. This permits the Data Communication processor to respond with an ACK (acknowledge) to the next Selection from the data center (after checking the parity of each character of the Selection message); it responds with a NAK when it is not receive ready. After receiving the ACK response, the data center transmits the message to the TC 500.

The Data Communication processor parity checks each character, places it in the Receive buffer, checks the Block Check Character for longitudinal parity accuracy, checks the Transmission number, sets the Message Received flag (R2) and turns on the Message Received indicator (Input indicator 3). The user program can determine that a message has been received by interrogating the flag using SKIP and EXECUTE instructions, and can then perform any necessary operations with the message data.

Once a message has been received and the Message Received Flag is turned on, the Data Communication processor does not permit the receipt of other messages until the flag is turned off by the user program. Thus, the message may remain in the Receive buffer indefinitely, and the user program may continue to operate on other work (such as preparing a message for transmission) until it is convenient to use the received message data.

The receipt of a valid message while in the Receive Ready state causes the automatic transmission of an ACK to the data center. The receipt of a message that has character or longitudinal parity errors causes the automatic transmission of a NAK to the data center. If the TC 500 does not receive a message from the data center following acknowledgement to the data center of a Selection, no response is made by the TC 500. This is treated in the same manner as failure of the data center to receive a transmitted ACK or NAK. It causes a "time out" at the data center and the Selection message must be re-transmitted.

If the message transmitted to the TC 500 from the data center contains more than 255 characters of text, the TC 500 will respond with a negative acknowledgement (NAK).

TRANSMIT READY STATE

Messages to be transmitted are prepared and stored in the Data Communications Transmit buffer by the user program. When the message is complete, or when it is known that all positions available in the buffer have been filled, the user program sets the Transmit Ready Flag (R3) by means of a SET instruction. The Data Communication processor then sets the remote in the transmit state so that when the next poll is addressed to this remote, automatic transmission will occur. In the meantime, the user program may commence with preparation of the next message to be transmitted or it may begin processing a message that has been received.

When the Poll is received from the data center and each character of the poll message has been parity checked, the Data Communication processor initiates the transmission of the message. It automatically inserts the Communication Control Codes and Transmission number (SOH, AD1, AD2, TR#, STX, ETX), generates a parity bit for each character, generates a longitudinal parity character (BCC), placing it after the ETX, and transmits the message.

Following transmission of the message, the Data Communication processor is in a Polling Message Response state and awaits receipt of an acknowledgement (ACK) from the data center; after receiving the ACK, it transmits an EOT character. If the data center responds with a NAK, the Data Communication processor automatically retransmits the message. Failure of the data center to transmit a recognizable character while the Data Communication processor is in the Polling Message Response state will not affect the remote. It is still output ready and the message can be re-transmitted when this address is repolled. Failure of the data center to receive EOT may cause a "time out" at the data center indicating that the TC 500 must be repolled.

When transmission of the message is successful, the Data Communication processor automatically increments the Transmission number, turns off the Transmit Ready light, and resets the Transmit Ready Flag (R3). This permits the user program to determine that the Transmit buffer is available to receive data from the keyboard or Normal memory for the next message.

RECEIVE BUFFER

The Receive Buffer has a capacity of 256 characters (32 words of 8 characters each, each character occupies 8 bits). However, the maximum text length is 255 characters, since the ETX must also fit into the buffer. When a message is received, only the text of the message and ETX are placed in the Receive Buffer; that is, all of the Heading, including the Start of Text character (STX) and the Block Check character (BCC) are striped off of the message. The End of Text character (ETX) will be placed in the Receive Buffer immediately following the last character of the actual text. If the text is greater than 255 characters, the Data Communication Processor will return a Negative Acknowledge (NAK) to the data center.

When a message has been correctly received, the Message Received Flag (R2) is set and the Message Received Indicator light is turned on. The user program determines that a message has been received by interrogating flag R2 using Skip or Execute instructions and branching to an appropriate routine to break apart or "unpack" the message data for printing, processing, etc. This "unpacking" may be done directly from the Receive buffer, or the entire contents of the Receive buffer may first be transferred into a Normal memory working area of 32 words which is then referred to as a "Receive Record Area" and which may be in any available section of Normal memory (except words 0 to 31). Several such Receive Record areas may be used if desired. When a message has been transferred from the Receive buffer to a Receive Record area (prior to unpacking), it permits receipt of another message while the first message is being processed.

The message data is contained in the Receive buffer or Receive Record area without regard to word boundaries, but rather as one continuous string of characters. The instructions used to unpack the message automatically keep track of word boundaries and the character position location in the buffer or record area so that the program may access one character or any size group of characters, thus providing complete character addressability.

When more than one terminal is connected to the same line, it is recommended to move messages to a normal memory working area before unpacking the data. This will improve throughput since the D.C. processor must examine each poll and select on the line, during which data transfer instructions will be delayed, if they go directly from the Receive Buffer.

TRANSMIT BUFFER

The Transmit Buffer also has a capacity of 256 characters (32 words of 8 characters each, each character occupies 8 bits). In preparing a message for transmittal to the data center, only the text of the message needs to be assembled and may be up to 255 characters in length. The heading, STX, ETX and BCC characters are automatically inserted in the message during transmission. The ETX is automatically placed after the last actual character of text and the remainder of the buffer capacity is ignored during transmission. If the text is more than 255 characters, only 255 characters are accepted and ETX is inserted as the 256th character. The Transfer instruction is terminated and the Overflow Test flag is set when an attempt is made to place more than 255 characters in the buffer or record area. The user program may take corrective action after having interrogated this test flag.

The Transmit Buffer is available to receive data for the next transmission once the Transmit Ready Flag (R3) has been Reset (by the Data Communication processor). The user program makes this determination by interrogating flag R3 with Skip or Execute instructions and branching to an appropriate routine to load data into the Transmit buffer.

The message may be constructed directly in the Transmit Buffer, or it may first be assembled in a Normal memory working area of 32 words which is then referred to as a "Send Record Area" and

which may be in any available section of Normal memory (except words 0 to 31). Several such Send Record areas may be used if desired. When the message has been completed, one instruction permits the entire contents of the Send Record area to be transferred to the Transmit buffer.

The instructions used to construct a message include the capability to place the message data in the buffer or record area sequentially without regard to word boundaries, as one continuous string of characters. As the message is assembled, the instructions automatically keep track of word boundaries and the character position location of the last character entered, thus providing complete character addressability.

It is not possible to construct a message non-sequentially; that is if a message consists of fields A, B, C, D, and E in that relative order, field A must be moved into the message before B, B before C, etc.

UNITED STATES OF AMERICA STANDARD CODE FOR INFORMATION INTERCHANGE

The United States of America Standard Code for Information Interchange is the internal code of the TC 500.* In addition, the characters that are transmitted via data communications are USASCII with an even parity bit. The parity bit will never be seen by a programmer in the transmit buffer, however, because it is added to each character as each character is being transmitted to the central processor. Characters in the receive buffer do have the parity bit, however. The following chart depicts graphically how these characters would look as they traveled on-line.**

CH	CD	CH	CD	CH	CD	CH	CD
Sp	A, 0	0	3, 0	@	C, 0	P	5, 0
!	2, 1	1	B, 1	A	4, 1	Q	D, 1
"	2, 2	2	B, 2	B	4, 2	R	D, 2
#	A, 3	3	3, 3	C	C, 3	S	5, 3
$	2, 4	4	B, 4	D	4, 4	T	D, 4
%	A, 5	5	3, 5	E	C, 5	U	5, 5
&	A, 6	6	3, 6	F	C, 6	V	5, 6
'	2, 7	7	B, 7	G	4, 7	W	D, 7
(	2, 8	8	B, 8	H	4, 8	X	D, 8
)	A, 9	9	3, 9	I	C, 9	Y	5, 9
*	A, A	:	3, A	J	C, A	Z	5, A
+	2, B	;	B, B	K	4, B	3/4 ([)	D, B
,	A, C	½ (<)	3, C	L	C, C	¢ (\ )	5, C
-	2, D	=	B, D	M	4, D	CR (])	D, D
.	2, E	¼ (>)	B, E	N	4, E	° (^)	D, E
/	A, F	?	3, F	O	C, F	_	5, F
				DEL	F, F	<> (~)	7, E

Notice these bit configurations are the same as the USASCII chart except for the addition of an upper 8-bit (parity) in some cases.

** **The upper 8-bit is turned on by firmware if the sum of the bits already on is odd. (Firmware adds one bit to make it even.)**

* **See Appendix H.**

ESTB

(DC)

ESTABLISHING RECEIVE/TRANSMIT RECORD AREAS

Establish Record Areas

	LABEL	OP CODE	A	B
ESTABLISH RECEIVE RECORD AREA	RECEIV	ESTB		
ESTABLISH SEND RECORD AREA	SEND	ESTB		

It is sometimes desirable to use a receive record area to unpack messages while freeing the data comm receive buffer to accept more data. These receive record areas have a counterpart in the transmit record areas, used to prepare a message for transmission while another message is in the transmit buffer awaiting a poll from the central processor.

These record areas are always thirty-two words (1 track) in length and are assigned space in memory by the assembler according to two things:

1. Memory size – as specified by the option card "$ MEMORY X"
2. and by the use of the pseudo instruction ESTB.

The first use of the ESTB pseudo instruction will cause the assembler to assign the record area to the highest thirty-two words of memory available (as indicated by the memory size option card) in user memory. The second use of the ESTB instruction will cause the record area to be established in the next 32 words of user memory available. For example, if user memory is 384 words, (0-383), the first record area will be in words 352-383. The second use of ESTB will establish the record area in words 320-351.

The ESTB pseudo instruction has no parameter, but it must always be labeled.

So far, we have only established receive and transmit record areas. The use of them will be discussed later.

NOTE: If the last user word is specified in assembly rather than the total number of user words of user memory (example: 383 rather than 384), the assembler will select the next lower track available (example: words 320 to 352). This would cause the last 32 words to be inaccessible to the assembler for other use.

An alternate, but less compact and less frequently used method of reserving main memory buffer areas is to specify a word value as in the following examples which assume 384 words of memory:

Alternate Method to Establish Record Areas

LABEL	OP CODE	A
	ORG	352
RECEIV	REG	32

In this example, Receive would be assembled with a starting word of 352. The word number must be the first word of a track. Track 0 is not a valid entry.

LRBR
RCP
IRCP (DC)

Any number of transmit or receive record areas may be used. The number is determined by programing requirements and memory availability.

TRANSFERRING DATA FROM ONE MEMORY ADDRESS TO ANOTHER MEMORY ADDRESS

The unpacking of messages received and the constructing of messages to be transmitted usually involves moving data FROM one memory location TO another. The transfer can be from a record area to the transmit buffer, from the receive buffer to a memory location, or from one memory address to another memory address. There are other combinations. The point is, the memory address that data is being transferred FROM and the memory address that data is being transferred TO must be designated. The next two sections explain this procedure.

Load Receive Buffer Register

	LABEL	OP CODE	A
LOAD RECEIVE BUFFER REGISTER		LRBR	BLANK OR LABEL

The LRBR instruction designates the starting memory address from which data will be transferred until the next LRBR is encountered. It is the origin address. The A parameter is the label of a memory address, often a record area which has already been established. The A parameter may be blank, however, in which case the data will be transferred directly from the Receive Buffer. Each time the LRBR instruction is executed, the character pointer for that record area or buffer is set to 1. This means the first character transferred will be the high order character of the first word in the designated memory location.

Set Receive Character Pointer

	LABEL	OP CODE	A
SET RECEIVE CHARACTER POINTER		RCP	1-255

Each use of the LRBR instruction sets the associated character pointer to one. For each character transferred or printed from the track, this character pointer is incremented serially. However, the RCP instruction permits transfer of data starting from any of the 255 character positions in the buffer, record area, or memory address.

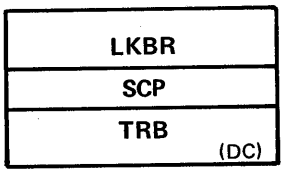
This instruction would allow serial transfer of characters starting with character designated by A.

Increment Receive Character Pointer

	OP CODE	A
INCREMENT RECEIVE CHARACTER POINTER	IRCP	0-255

The IRCP instruction increments the receive character pointer by the number of character positions designated in the A field, or until the next field indentifier code is encountered.* The pointer is incremented for the field identifier code also. This instruction permits by-passing a data field in a message containing variable length fields.

*See page 2-74.



Load Keyboard Base Register

	OP CODE	A
LOAD KEYBOARD BASE REGISTER	LKBR	BLANK OR LABEL

The LKBR instruction designates the starting memory address to which data will be transferred, until the next LKBR is encountered. It is the destination address. (The A parameter is the label of a memory address, often a record area.) The A parameter may be blank however, in which case the data will be transferred directly to the transmit buffer. Each time the LKBR instruction is executed, the Send Character Pointer for that memory address, record area or buffer is set to 1. This means the first character transferred will be placed in the high order digit positions of the first word of the designated memory location.

Set Send Character Pointer

	OP CODE	A
SET SEND CHARACTER POINTER	SCP	1-255

Each use of the LKBR instruction sets the associated character pointer to one. For each character transferred to this track, the character pointer is incremented serially, and the current position of the send pointer designates the position to which data will be transferred when the next transfer instruction is implemented. The SCP instruction permits transfer of data to the designated buffer or transmit record or work area beginning at the character position shown in the A parameter.

UNPACKING MESSAGES RECEIVED

Normally, when transferring the contents of a word in the Accumulator, the whole word is transferred. Likewise, when printing the alpha contents of a word, the entire contents (up to an end alpha code) are printed. The data comm instructions used to unpack messages pay no attention to word boundaries in the receive buffer or receive record area. In Data Communication programing, it is possible to transfer any number of digits up to 16 to the Accumulator and it is possible to move alpha characters from one location to another regardless of the number of word boundaries crossed.

Transfer Receive Buffer

The TRB instruction will transfer the entire contents of the receive buffer into the receive record area as described by the A parameter.

	OP CODE	A
TRANSFER RECEIVE BUFFER TO RECORD AREA	TRB	LABEL

The use of the TRB instruction assumes that a receive record area has been established by one of the routines previously described in this section. (It is possible to use the TRB instruction with a label in the A parameter that references a memory address other than an established receive record area. However, the entire 32 word receive buffer will be transferred, overlaying the 32 words following the base address referenced by the LRBR.) There can be several such record areas, depending upon user memory available and the program requirements and any of them may be accessed by the A parameter.

Transfer to Accumulator as Numeric

	OP CODE	A
TRANSFER TO ACCUMULATOR AS NUMERIC	TRBA	0-16

Since the Accumulator has a maximum of 16 digit positions available, 16 digits is the maximum number permissible in the A parameter of this instruction. This instruction is terminated before the "A" number of digits are transferred if a field identifier code is encountered.

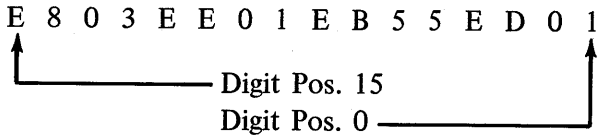
The TRBA instruction moves characters from some memory address. As was discussed earlier, when moving data from memory, the LRBR instruction indicates from where. So, the last LRBR instruction, at the current RCP position, will indicate from which buffer or record area and from which position in that buffer the transfer will take place.

No matter, however, where the digits are being transferred from, they will be placed in the Accumulator as numeric digits. This deserves some special consideration.

Example:

	OP CODE	A
TRANSFER TO ACCUMULATOR AS NUMERIC	TRBA	16

Result in Accumulator:



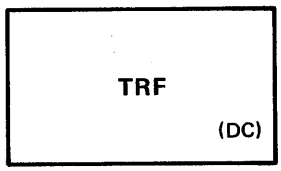
In this instance, the "E's," "B's," and "D's" in the Accumulator resulted from a 3,E, and a 3,B, and a 3,D in memory which are valid codes for the TRBA instruction. The "E" in the Accumulator is, in reality, a hexadecimal 14, the "B" a hexadecimal 11, and the "D" a hexadecimal 13.

NOTE: Let's say the contents of the Accumulator were moved to a memory location, e.g., word 30. Word 30 would then look like this:

syllable 0 : E301
syllable 1 : EB55
syllable 2 : EE01
syllable 3 : E803

These are the machine codes for these mnemonics:

LABEL	OP CODE	A	B	C	REMARKS
	AL	1			Advance left 1
	POS	55			Position to 55
	AR	1			Advance right
	OC	3			Open carriage, advance 3



It is important to remember that the TRBA instruction, while designed to transfer one character at a time into the Accumulator, must "scoop up" two digit positions from the memory location indicated by the current LRBR and RCP instruction in order to determine the digit being transferred. Look at the USASCII chart again page 2-65 Every code in the table is represented by a row and column and must occupy 8 bits. The "numbers" in the table are located in column three. Since there are 16 rows in the table, column 3 has 16 entries: 0-9 and the hexadecimal digits (A, B, C, D, E, and F) ":", ";", "<", "=", ">", and "?". This information is useful when, for instance, an "A" is desired in the Accumulator as a result of a TRBA instruction. The central processor would send to the TC 500 the USASCII equivalent of a colon (:). In USASCII code, it is "3,A." When the TRBA instruction encounters the 8 bit representation of a colon (3,A), the upper four bits are pared off and the lower four bits are placed in the Accumulator.

Used this way, the TRBA instruction is an instrumental tool for loading programs in the TC 500 using codes sent from a central processor.

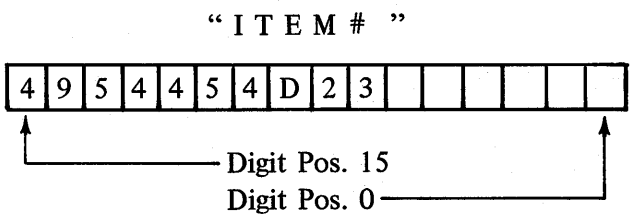
Transfer Alpha

	OP CODE	A
TRANSFER ALPHA	TRF	0-255

The TRF instruction transfers alphanumeric (8 bit) characters from the memory location specified by the last LRBR instruction beginning at the current RCP position to the memory location specified by the last LKBR instruction beginning at the current SCP position. The number of characters to be transferred is specified by the A parameter of the TRF instruction; the instruction is terminated by the transferring of the exact number of characters specified or by encountering a field identifier code. When the instruction is terminated, no matter how it is terminated, (by reaching the number of characters specified or by encountering a field identifier code) an end of alpha code will be inserted in the next character position of the memory address indicated by the LKBR. The SCP is not incremented for that code, however.

The following example attempts to show how several product codes, which have come from a central processor, can be stored in TC 500 user memory:

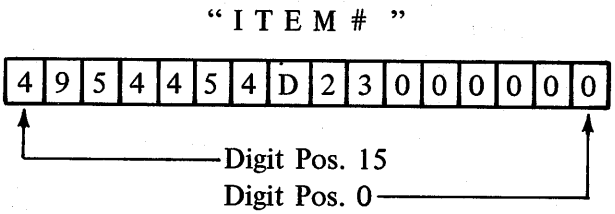
First word of Receive Buffer:



Example:

	LABEL	OP CODE	A
LOAD RECEIVE BUFFER REGISTER		LRBR	STORE
LOAD KEYBOARD BASE REGISTER		LKBR	STORE
TRANSFER ALPHA		TRF	5
RESERVE REGION	STORE	REG	1

This is what "STORE" would look like after the transfer:



The RCP and SCP are incremented for each character transferred; the RCP will also be incremented for a field identifier code if one is present. The overflow flag will be set if either pointer is incremented past 255, or if ETX is received.

Print Alpha From Memory Location Designated By Last LRBR Instruction

	OP CODE	A
PRINT ALPHA RECEIVE BUFFER	PAB	0-150

The PAB instruction usually is used with a receive buffer or record area but will print from any memory location designated by the last LRBR instruction beginning with the current RCP position. The printing will continue until the exact number of characters have been printed, or until a field identifier code is encountered. For each character printed, the RCP will be incremented by 1. If the RCP is incremented past 255, the overflow flag will be set.

Example:

	LABEL	OP CODE	A
LOAD RECEIVE BUFFER REGISTER		LRBR	RECEIV
PRINT ALPHA		PAB	15
ESTABLISH RECEIVE RECORD AREA	ESTB	RECEIV	

NOTE: It is also possible to print from memory using the PA instruction. The distinction is the flexibility of the PAB instruction since it allows the programmer to designate a starting character position within a word (done by setting RCP) and to designate the exact number of characters to be printed. The PA instruction simply prints from the first character position of the word specified by its A parameter until it encounters the end alpha code.

PREPARING MESSAGES FOR TRANSMISSION

Remember from the discussion of unpacking messages received that instructions which transferred characters and printed characters were not limited by word boundaries. The transfer is guided by a character pointer (RCP). Likewise, in preparing a message for transmission, those instructions dependent on a character pointer (SCP) and an LKBR instruction are not limited by word boundaries.

TSB
TRAB (DC)

If any of these instructions are used to transfer data to the transmit buffer while the transmit ready flag is set, the instruction is held up from being executed. Normally, the transmit ready flag is interrogated before information is moved into the transmit buffer.

Transfer Send Record Area

A message may be prepared for transmission in a user memory send record area and then be transferred to the transmit buffer. This transfer will move the entire 32 words of a send record area to the transmit buffer. The send record area is determined by the A parameter of the TSB instruction. The A parameter is the label of a record area established by one of the routines using ESTB. The End of Text Character will be automatically inserted after the last character of the message.

	OP CODE	A
TRANSFER SEND RECORD AREA	TSB	LABEL

Transfer from the Accumulator into the Memory Address Specified by the Last LKBR

	OP CODE	A	B
TRANSFER ACCUMULATOR TO "LKBR"	TRAB	0-15	0 or 1

The TRAB instruction will transfer up to 15 numeric digits (4 bits) from the Accumulator into the memory location designated by the last LKBR instruction, placing the digits into memory as 8 bit alpha characters beginning with the current position of the SCP.

The digit position of the Accumulator from which digits are to be transferred is designated by the A parameter. The B parameter must be either a zero or one: A "1" meaning leading zeros will be transferred and a "0" meaning leading zeros will not be transferred.

Example:

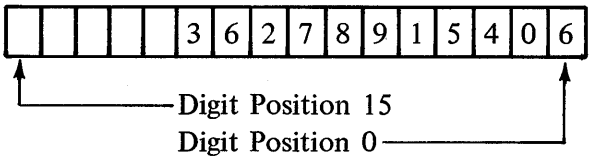
	LABEL	OP CODE	A	B
LOAD KEYBOARD BASE REGISTER		LKBR	ADRES	
TRANSFER ACCUMULATOR		TRAB	10	1
ESTABLISH 2 WORD REGION	ADRES	REG	2	

The transfer could also have been to the send buffer or send record area.

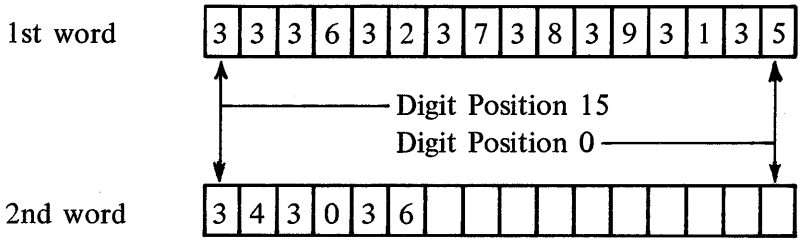
Example:

	OP CODE	A	B
LOAD KEYBOARD BASE REGISTER	LKBR		
TRANSFER ACCUMULATOR TO LAST "LKBR"	TRAB	10	0

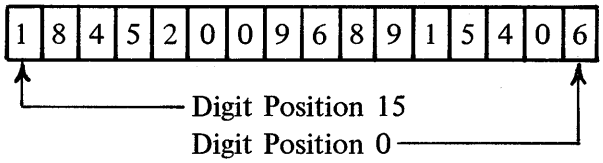
If the Accumulator looks like this prior to execution of TRAB:



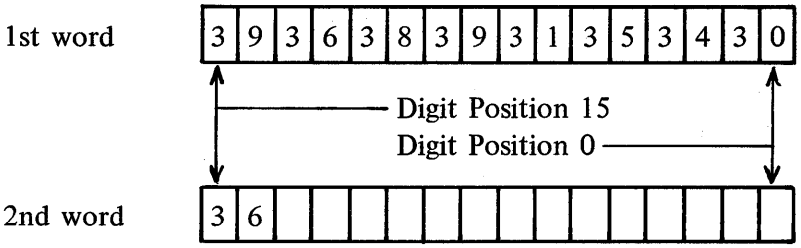
then the first and second words of the transmit buffer would look like this after the execution:



If the Accumulator looked like this prior to execution of the same instructions:



then the first and second words of the transmit buffer, would look like this:



Those digits occupying positions in the Accumulator higher than the digit position specified by the A parameter were ignored, and, since preceding zeros were not transferred, the first digit moved was the "9" in digit position 8.

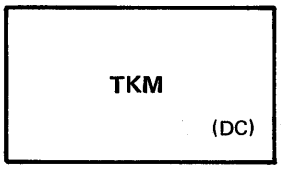
Transfer Alphanumeric Data

	OP CODE	A
TRANSFER ALPHA	TRF	0-255

Refer to Page 2-70 for complete discussion of this instruction.

Transfer Character to Memory Address Specified by the Last LKBR

	OP CODE	A	B
TRANSFER CHARACTER TO	TRCB	0-15	0-15



The TRCB instruction transfers the USASCII code designated by the decimal value in the "A" and "B" parameters into the memory address specified by the last LKBR instruction, with the first character being transferred to the position indicated by the current position of the SCP. For each character transferred, the SCP is incremented by one.

To use this instruction, it is necessary to know the USASCII row and column designation of the character to be transferred. The A parameter indicates the column number from the USASCII table, and the B parameter is the row number.

For example, if an asterisk (*), USASCII column 2, row 10, is to be placed in the buffer, then the instruction to accomplish this is:

	OP CODE	A	B
TRANSFER CHARACTER TO	TRCB	2	10

Type to Memory

OP CODE	A	B
TKM	0-150	

The TKM instruction allows the operator to enter data directly into the memory address specified by the last LKBR beginning with the current position of the SCP. The SCP will be incremented for each character entered and an end of alpha code will be placed in memory after the last character ended. However, the SCP is not incremented for this character.

The use of the backspace key will cause the SCP to be decremented for each depression. However, the SCP cannot be decremented beyond the position held when the TKM instruction was encountered.

	LABEL	OP CODE	A
LOAD KEYBOARD REGISTER		LKBR	AREA
TYPE INTO MEMORY		TKM	16
ESTABLISH 4 WORD REGION	AREA	REG	4

The instruction may have been used to enter data into the transmit record area:

	LABEL	OP CODE	A
LOAD KEYBOARD BASE REGISTER		LKBR	SEND
TYPE INTO LAST "LKBR"		TKM	25
ESTABLISH SEND RECORD AREA	SEND	ESTB	

FIELD IDENTIFIER CODES AND VARIABLE LENGTH FIELDS

Imagine a situation where a customer's name, street address, city and state are being transmitted to the TC 500 to be printed on 3 different lines of an invoice. Further, let's assume the message is in the

Receive Buffer and the programmer wishes to use the PAB instruction to print the name on the ship-to portion of the invoice. What should the programmer put in the A parameter of the PAB instruction? If the name is "Acme Printing," the A parameter should be 13 characters. Names are of variable length, however, and there is a convention in GP 300 that allows for varying length fields. This convention is called a "field identifier code." Whenever a field identifier code is encountered by any of the following data comm instructions, execution is terminated and the next instruction will begin. These instructions are:

LABEL	OP CODE	A	B	C	REMARKS
	TRBA	0-16			Transfer as numeric
	TRF	0-255			Transfer alpha
	PAB	0-150			Print from buffer

Valid field identifier codes are in columns 0 and 1 of the USASCII Chart. The two charts below show the codes, their 4 bit hexadecimal value and their accompanying flag patterns.

The codes from column 0 present problems if the "Y" flags are used in the TC 500 user program. After reading a column 0 field identifier code, all four Y flags are either set, set or reset and the appearance of these Y flags could seriously upset the logic of the TC 500 program if the Y flags are interrogated and acted upon without knowledge of these additional flag settings. This same problem could arise when reading column 1 codes and when interrogating the K flags. Therefore, the use of these field identifier codes must be given careful consideration and their use must be coordinated with the central processor.

NO FLAGS SET	Y FLAGS SET*	K FLAGS SET*	TEST FLAGS SET
	3 2 1 4	3 2 1 4	U I L O
NUL	SOH 0 0 0 1	DC1 0 0 0 1	ETX 0 0 0 1
	STX 0 0 1 0	DC2 0 0 1 0	
		DC3 0 0 1 1	
		DC4 0 1 0 0	
	ENQ 0 1 0 1	NAK 0 1 0 1	
	ACK 0 1 1 0	SYN 0 1 1 0	
	BEL 0 1 1 1	ETB 0 1 1 1	
	BS 1 0 0 0	CAN 1 0 0 0	
	HT 1 0 0 1	EM 1 0 0 1	
	LF 1 0 1 0	SUB 1 0 1 0	
	VT 1 0 1 1	ESC 1 0 1 1	
	FF 1 1 0 0	FS 1 1 0 0	
	CR 1 1 0 1	GS 1 1 0 1	
	SO 1 1 1 0	RS 1 1 1 0	
	SI 1 1 1 1	US 1 1 1 1	

*Y and K flags designated are set if "1" and reset if "0"

It is generally agreed that many of the above USASCII codes should never appear in a text. EOT is specifically filtered out by the Data Communications Processor. NUL does serve as a field identifier but, as indicated in the chart above, it terminates the instruction but does not set any flags; neither does it

reset any previous flags. It merely terminates the instruction. ETX has special significance in that when ETX is detected during a transfer instruction, the Overflow flag will be set and the instruction terminated.

Many of the above codes should not appear in a text but if they do, the TC 500 will accept them and set the flag pattern indicated above. The chart below shows the codes that normally can be a part of a text message. Some codes from the above chart may be excluded by Central Processors or by Line Adapters. Applicational programing should consider these as termination and flag setting codes rather than the entire range listed in the above table.

NO FLAGS	Y FLAGS	K FLAGS	TEST FLAGS
	3 2 1 4	3 2 1 4	U I L O
NUL			ETX 0 0 0 1
		DC1 0 0 0 1	
		DC2 0 0 1 0	
		DC3 0 0 1 1	
		DC4 0 1 0 0	
	BS 1 0 0 0		
	HT 1 0 0 1		
	LF 1 0 1 0		
	VT 1 0 1 1		
	FF 1 1 0 0	FS 1 1 0 0	
		GS 1 1 0 1	

Now let's look at some examples in which we will attempt to show proper use of field identifier codes.

Example 1:

An invoice ship-to region has been defined as consisting of from 2 to 4 lines of not more than 25 characters per line. In addition, the last line of the ship-to address will determine if the sold-to address is "SAME" or if it requires a separate address.

PROBLEM: The TC 500 programmer must program for variable length fields and for variable number of fields. He must also make a decision whether to print "SAME" in the sold-to address area or to begin printing a new sold-to address.

DECISION: After each field or line of the ship-to address a field identifier code will be inserted by the central processor. Let's make this "DC1," except for the last line of the ship-to address which will be "DC2" if the sold-to address is "SAME" or a "DC4" if sold-to address is another distinct address. A "CAN" code will terminate the last line of the sold-to address.

Here are some programing suggestions that will accomplish the necessary invoice addressing routine. (Assume the necessary steps have been taken to establish a receive record area, to establish alpha constants, etc.)

This routine is very flexible. Each line printed can be of any length up to 25 characters. If the field (line) is less than 25 characters*, the field identifier will terminate the instruction and set a K flag pattern. Also, there may be any number of lines to an address since either K1 or K2 will mark the end of the last line of the address.

LABEL	OP CODE	A	#	B	C	REMARKS
PRTLIN	LRBR	RECEIV				Load Receive Buffer Register
	AL	2				Advance left 2 lines
	RST	K		1234		Reset K flags
	POS	5				Position to print
	PAB	26				Print on address line
	EX	K		4	1	K4 – means more lines
	BRU	PRTLIN				Print another line
	EX	K		1	3	K1 – ship-to = sold-to
	AL	5				Advance to sold-to area
	PA	SAME				Print "SAME"
	BRU	OUT				Exit the routine
	EX	K		2	2	K2 – means sold-to address
	AL	5				Advance to sold-to area
	BRU	PRTLIN #1				Base to print new address
	EX	K		3	1	K3 – end of address routine
	BRU	OUT				Exit the routine

Example 2:

This example shows how field identifier codes may be helpful while constructing messages for transmission to the central processor.

Assume we are in a file maintenance routine and wish to send the name and number of a customer to the central processor. Every name has a corresponding number.

***Notice the A parameter of the PAB instruction is 26. The problem definition permits only 25 characters per line. In the event, however, the field is exactly 25 characters long, the extra character in the A parameter will allow the PAB instruction to pick up the field identifier code. Otherwise, the character pointer will be pointing at the 26th character at the time of execution of the next PAB instruction since it is not incremented when reading an F.I. This PAB instruction would read the field identifier and terminate, instead of reading the next field.**

PROBLEM: The TC 500 programmer must allow for several such combinations of names and numbers and also must distinguish between the names and numbers.

DECISION: Every name will be followed by the field identifier "DC2." Every customer number will be identified by a trailing "DC4" if there are more names and numbers to follow or a "CAN" if the current customer number is the last one. After indexing a name, the operator terminates with OCK 1. After indexing a number, the operator terminates with OCK 2 if there are more names and numbers and OCK 3 or OCK 4 if there are no more.

LABEL	OP CODE	A	#	B	C	REMARKS
LODBUF	LKBR	XMIT				Load transmit buffer
	AL	2				Advance to type
	POS	5				Position to print
	TKM	25				Index name/number
	EX	K		1	2	K1 – means name
	TRCB	1		1		1,2 = DC2 = OCK 1
	BRU	LODBUF	#1			Index again
	EX	K		2	2	K2 – means number
	TRCB	1		2		1,4 = DC4 = OCK 2
	BRU	LODBUF	#1			Index again
	EX	K		3,4	3	K3,4 – last number
	TRCB	1		8		1,8 = CAN = OCK 3
	SET	R		3		Set transmit flag
	BRU	AWAY				Exit routine

The point was made earlier in this section that many data communications instructions involve moving data from one memory address to another. Most of the instructions moving data from a memory address

have a counterpart for moving data to a memory address. The following chart depicts these characteristics:

CAPABILITY (TO) *	INSTR	INSTR	(FROM) CAPABILITY
Transfer All Data to "N"	LKBR	LRBR	Transfer All Data From "N"
"To" Character Pointer	SCP	RCP	"From" Character Pointer
Transfer Alpha To "N"	TRF	TRF	Transfer Alpha From "N"
Transfer Numeric To "N" (usually Transmit Buffer)	TRAB	TRBA	Transfer Numeric From "N" (usually Receive Buffer)
Transfer "N" To Transmit Buffer (N usually Send Record Area)	TSB	TRB	Transfer From Receive Buffer (usually Receive Record Area)
Type to "N"	TKM	PAB	Print From "N" (N usually Receive Buffer)
Transfer Character To "N" (N usually Transmit Buffer)	TRCB	None	
	None	IRCP	Increment "From" Character Pointer

When the TKM instruction is terminated by the use of an OCK or a PK, an end of alpha code is automatically inserted behind the last character indexed. However, the SCP is not incremented for that character. Therefore, unless a field identifier code is inserted or unless the SCP is changed, the next TKM or TRCB instruction will begin immediately after the last text character.

When the central processor reads the field identifier codes, it will be able to determine the next appropriate action depending on the code read.

"D" FLAG GROUP

In addition to the message received (R2) and transmit ready (R3) flags, there is a corresponding pair of flags – the data comm processor transmit ready (D3) flag and the data comm processor message received (D2) flag – that give the programmer a faster indication of the status of the transmit and receive flags. Since R2 and R3 are set or reset, respectively, by firmware only after D2 and D3 have been interrogated, it might be faster for a programmer, for example, to interrogate the D3 flag with a standard SKIP or EXECUTE instruction and programmatically reset R3 (as opposed to waiting for firmware to do it). A new message could then be transferred to the transmit buffer and the transmit ready light could again be set.

OTHER DATA COMMUNICATION INSTRUCTIONS

GP 300 has a group of instructions that allows the programmer to assume some firmware responsibilities. An example is the transmission number that is part of the header portion of a message. This number is usually calculated by firmware and is not an important programing consideration. However, there are two instructions in GP 300 that allow the programmer to transfer the transmission number to the Accumulator and also to assign any 1, 2, or 3 digit number to the transmission number.

***N signifies a memory location**

RSA
LSA (DC)

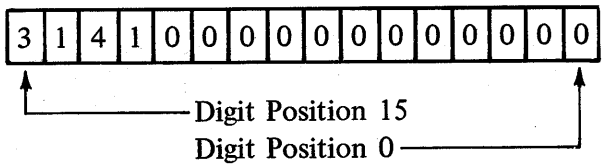
The following section will discuss several similar instructions and their proper use.

Transmit Address

1. Retrieve Send Address

	OP CODE
RETRIEVE SEND ADDRESS	RSA

After this instruction has been executed, the four most significant digit positions of the Accumulator will contain the two-character machine send address. These are alpha characters and each character will occupy two digit positions in the Accumulator. For example, if the send address is 1A, then the Accumulator will look like this after execution of the RSA instruction.



It is then up to the programmer to manipulate, store, print, or change the machine address.

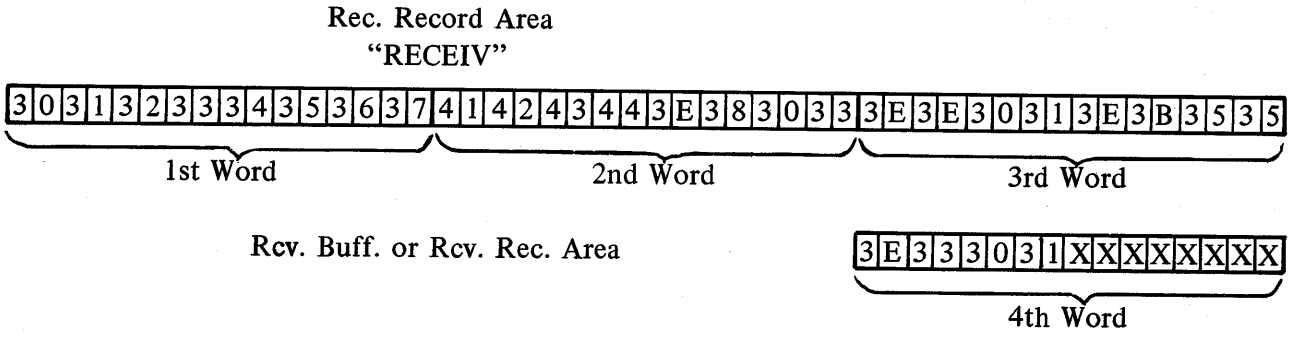
2. Load Send Address

	OP CODE
LOAD SEND ADDRESS	LSA

Upon execution of this instruction, the four high order digit positions of the Accumulator will be committed to memory as the Send Address for the TC 500.

These are 8 bit alpha characters, (refer to preceding examples) and, since they must occupy the high order positions of the Accumulator, the numeric keyboard instructions are not best suited to arrange the data in the Accumulator as required. This is particularly true since the operator must know the USASCII chart to accomplish the data format. For example, if the desired Send Address is "XY," then "5,8" and "5,9" (the USASCII equivalent of XY) would be entered.

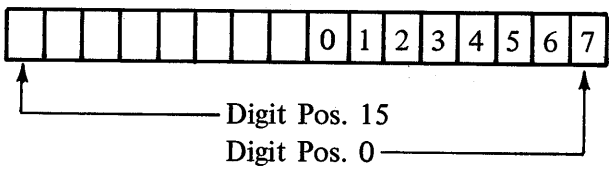
All characters in the transmit buffer are USASCII coded. They are 8 bit characters. When the characters are placed in the Accumulator as numeric digits, they are 4 bit. Thus, they lose the upper four bits. This is true of any character in the receive buffer or record area, whether it is a USASCII alpha character or numeral. Therefore, the only valid characters which may be correctly transferred from the memory address indicated by the last LRBR into the Accumulator are from column 3 of the USASCII chart, any of the field identifier codes and also the "+" and "–" characters from column 2. If an invalid code is transferred into the Accumulator, the S flag will be set, the RCP will be incremented, and the transfer will continue. Here are some examples:



Example 1

	OP CODE	A
LOAD RECEIVE BUFFER REGISTER	LRBR	RECEIV
TRANSFER TO ACCUMULATOR AS NUMERIC	TRBA	8

Result in Accumulator:

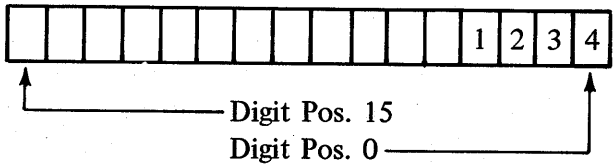


At this point, the RCP is at 9. Note that it will not be necessary to again designate where digits will be transferred from if "RECEIV" is going to be the donor address. The next example is intended to show the result when invalid characters are transferred into the Accumulator, using the current RCP position.

Example 2

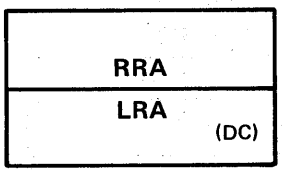
	OP CODE	A
TRANSFER TO ACCUMULATOR AS NUMERIC	TRBA	4

Result in Accumulator:



In this instance, the characters in the buffer were respectively, A, B, C, and D. They were alphabetic characters, and, when transferred into the Accumulator as numeric using the TRBA instruction, the upper four bits were pared off, leaving the lower four bit representation. Also, the Accumulator S flag was set, which could have been interrogated and acted upon.

Look at a USASCII chart. Notice that the lower four bits of the USASCII representation of any of the codes from column 3 are the same as the numeral depicted, e.g., a "3" in the USASCII chart is 3,3 and a "7" is 3,7. When the TRBA instruction acts upon a 3,7 in memory, the result is a "7" in the Accumulator.



An easier approach utilizes alpha keyboard entries. The suggested sequence of instructions follows:

LABEL	OP CODE	A	REMARKS
	LKBR	WORK	Designate memory area
	TKM	2	Enter 2 character address
	TRA	WORK	Transfer to Accumulator
	LSA		Load Send Address
WORK	REG	1	Reserve one word

Receive Address

1. Retrieve Receive Address

	OP CODE
RETRIEVE RECEIVE ADDRESS	RRA

This instruction performs like the Retrieve Send Address instruction except it is the Receive Address that is brought into the four high order digit positions of the Accumulator. The Accumulator format is the same. Again, the program must provide for doing something with the contents of the Accumulator.

2. Load Receive Address

	OP CODE
LOAD RECEIVE ADDRESS	LRA

The Accumulator is transferred to the Receive Address Register by this instruction. The programing steps to get the Receive Address in the required Accumulator positions are the same as those outlined for the Send Address. (Refer to the Load Send Address instruction.)

NOTE: In addition to the Receive Send Addresses, the TC 500 has a permanent machine address. It is located in word 1064 and is substituted for the Receive and Send Addresses every time the power is turned on the TC 500 or when the program halt button is used. The Ready Button does not reload the Send and Receive Addresses. This address may only be accessed by unprotecting the 2nd track of Data Comm memory and using memory modify to change the permanent address.

Send Transmission Number

The TC 500 maintains a transmission number that accompanies every message it sends to a central processor. It may be a one, two, or three digit number. Upon receipt of an "ACK" from the central processor resulting from a successful transmission, the TC 500 increments the number by one. If the transmission number is one digit only, it will return to zero every ten transmissions. If it is a two digit number, it will return to zero after each one hundred transmissions; for a three digit number, it becomes

RSN
LSN
RTN (DC)

zero every one thousand transmissions. The number is not incremented, however, until the ACK has been received.

1. Retrieve Send Transmission Number

	OP CODE
RETRIEVE SEND TRANSMISSION NUMBER	RSN

This instruction transfers the 1, 2, or 3 digit USASCII Send Transmission Number from its register into the 2, 4, or 6 most significant digit positions of the Accumulator. The balance of the Accumulator will contain zeros. The programmer must decide what to do with the Send Transmission Number once it is in the Accumulator. Perhaps it will be printed, stored in memory, or incremented or decremented. It depends on the program requirements.

2. Load Send Transmission Number

	OP CODE
LOAD SEND TRANSMISSION NUMBER	LSN

Execution of this instruction will cause transfer of the Accumulator to the Send Transmission Number Register. Only the 2, 4, or 6 high order digit positions may contain significant digits. The rest must contain zeros. (The number of positions in the Accumulator that may contain significant digits is determined by the length of the Send Transmission Number – 1, 2, or 3 digits.)

Expected Transmission Number

The TC 500 maintains an Expected Transmission Number that it compares against the actual transmission number sent by the central processor. If the two numbers are equal, the TC 500 will increment the Expected Transmission Number. This number will return to zero, after 10, 100, or 1,000 transactions depending upon the length of the number chosen.

If the numbers do not compare, the Transmission Failure Flag will be set (D2) but the message is still received.

In most cases, the central processor will simply turn around the Send Transmission Number it receives from the TC 500 and send it back to the TC 500. In this way, the TC 500 is able to synchronize the sequence of messages it sends and receives. The messages the TC 500 receives are usually a response to the last message it transmitted. Synchronization is not a problem, then. Transmission number checking and manipulating may be desirable, however, whenever the TC 500 program is not receiving and transmitting messages one-for-one. The use of the RSN, LSN, and the following two instructions is left to the discretion of the programmer.

1. Retrieve Expected Transmission Number

	OP CODE
RETRIEVE EXPECTED TRANSMISSION NUMBER	RTN

LTN
RTH
RPR (DC)

This instruction transfers the 1, 2, or 3 digit USASCII numeric character "Expected Transmission Number" from its register into 2, 4, or 6 most significant digit positions of the Accumulator. The balance of the Accumulator will contain zeros. Just like the other "Retrieve" instructions, the programmer must decide how he will handle the data in the Accumulator; i.e., print, store, increment, etc.

2. Load Expected Transmission Number

	OP CODE
LOAD EXPECTED TRANSMISSION NUMBER	LTN

This instruction transfers the contents of the Accumulator in the Expected Transmission Number Register for messages received. Only the 2, 4, or 6 most significant digit position of the Accumulator may have significant characters. The balance of the Accumulator must contain zeros.

The data in the Accumulator must be represented by USASCII code. It is therefore suggested that the same approach used in loading the Send Address be used in loading the Expected Transmission Number.

Retrieve Transmission Number

	OP CODE
RETRIEVE TRANSMISSION HEADER	RTH

Execution of this instruction transfers into the Accumulator the contents of word 1184. This word contains the last transmission number received from the central processor. The transmission number is USASCII coded and occupies the 2, 4, or 6 high order digits of the Accumulator. The next 2 digit positions reveal the type of Select Character (since this word refers to the last message received) used during the last transmission. A broadcast select would be represented by a "t" (7/4); a fast select would be represented by a "s" (7/3); a group select is a "u" (7/5); and a select is a "p" (7/0).

This information will be in digit positions 13 and 12, or 11 and 10, or 9 and 8 depending upon the length of the transmission number.

Retrieve Character Pointer Register

	OP CODE
RETRIEVE POINTER REGISTER	RPR

This instruction will transfer the contents of the Character Pointer Register into the Accumulator. All digits in the Accumulator will be hexadecimal and the format of the Accumulator will be as follows:

					BLOCK	BLOCK							BLOCK	BLOCK		
	WORD	WORD			LOCK	LOCK	WORD	WORD	WORD	WORD			LOCK	LOCK	WORD	WORD
	ORD	ORD			CK	CK	ORD	ORD	ORD	ORD			CK	CK	ORD	ORD
digit positions	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
			RCP								SCP					
					BASE LRBR								BASE LKBR			
	WORKING LRBR								WORKING LKBR							

There is more information stored in the Character Pointer Register than just the character pointers. The Keyboard Base Register and the Receive Base Register have both their base address and their working address maintained in the Character Pointer Register. The meaning of the Accumulator format can best be explained with an example.

Let's say the Accumulator looked like this after execution of the RPR instruction:

digit position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
hexadecimal val.	6	2	0	C	1	1	6	1	4	3	1	3	1	1	A	1

Digit positions 8, 9, and 10 reveal the LRBR base position – word 96 of block 1 (351). Digit positions 12 and 13 are the current position of the Receive Character Pointer – 12. Digit positions 11,14, and 15 reveal the current word of memory being used as the Receive Base Register – word 97 of block 1 (352). This makes sense because the receive character pointer has been incremented 11 times. Since each word may contain 8 USASCII characters, the information transfer will be from LRBR base address plus 1 – word 352. The same logic applies to determining the status of the Send Character Pointer and the Keyboard Base Register.

Polled Flags Register

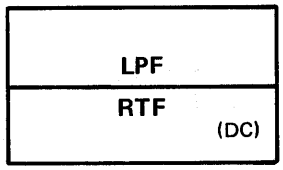
1. Retrieve Polled Flags Register

	OP CODE
RETRIEVE POLLED FLAGS REGISTER	RPF

This instruction transfers into the Accumulator the contents of the Polled Flags Register. This register is really only one digit (4 bits) in which each bit has significant meaning. Since this digit is transferred into the Accumulator sign position, the Accumulator flags may be tested and acted upon. Here is how the flags function, with their associated Accumulator flag shown:

POLLED FLAG	ACCUMULATOR FLAG	MEANING
3	M	This TC 500 has been polled or selected.
2	C	Another TC on the line has been polled or selected. This flag will be set when there is any polling or selecting for any other TC on the line.
1	S	There is a break in the communication line. The carrier drops from the CPU while the TC 500 is transmitting. This function pertains only to 4 wire systems.

Notice the Accumulator "–" flag is not represented. There is no corresponding Polled Flag.



After execution of the RPF instruction, the program should interrogate the Accumulator flags and perform according to the program requirements.*

2. Load Polled Flags Register

	OP CODE
LOAD POLLED FLAGS REGISTER	LPF

To load the Polled Flags Register, the Accumulator must be cleared and the Accumulator flags set or reset, depending upon the Polled Flags status required by the program. Then, execution of the LPF will load the Polled Flags Register with the flags set.

Two Wire/Four Wire Register

The TC 500 may be connected to a central processor two ways. When using a data set to establish connection with the central processor, the transmission media is known as "2 wire." When the data set is not used, and the TC 500 is on a "direct connect" line to the central processor, then the transmission media is known as "4 wire."

The Data Communications Processor contains a special register to enable two or four wire transmission mode. One bit in this register is used to determine which mode is active.

1. Retrieve Two Wire/Four Wire Register

	OP CODE
RETRIEVE TWO/FOUR WIRE REGISTER	RTF

Execution of this instruction will transfer the contents of the two wire/four wire register into the Accumulator. When the Accumulator M Flag is on, the mode is two wire; when it is off the mode is four wire. Like other "Retrieve" instructions, the user program must then interrogate the Accumulator flag and perform according to program requirements.

2. Load Two Wire/Four Wire Register

LABEL	OP CODE	A	B	C	REMARKS
	LTF				Load Two/Four Wire Register

***This instruction is most useful in debugging a new system. It will at least reveal if a poll or select from the central processor is getting through to the TC 500.**

Execution of this instruction will transfer the contents of the Accumulator into the Two or Four Wire Register. The mode will then be 2 or 4 wire depending upon the status of the Accumulator M flag at the time of execution.*

INPUT WITH PUNCHED PAPER TAPE/EDGE PUNCHED CARD READER

Instructions are provided to read punched paper tape or edge punched cards, using a Burroughs Style A 581 Paper Tape/Edge Card Reader as the input adjunct. All subsequent reference to "paper tape" applies both to punched paper tape and to edge punched cards, unless indicated otherwise.

Tape reading is serial, one character at a time, at a speed up to 40 characters per second (when no printing accompanies it). When reading paper tape and printing, the reading speed is up to 20 characters per second; when reading and punching only (no printing), reading speed is up to 40 cps.

The Series L/TC internal character code is USASCII; however, any 5, 6, 7, 8 channel paper tape code can be read and interpreted by utilizing a Table of Input Code Assignments for conversion of the paper tape code into the internal USASCII code. The functional codes in a code set may be used as field identifier codes to terminate tape reading and set flag patterns, or may be ignored (refer to the Table of Input Assignments in Appendix I). The scheme of character parity checking for a particular code set is also a function of the Table of Code Assignments. Firmware for 5 channel code is different than that for 6, 7, or 8 channel "table look-up" firmware or for USASCII No Table firmware.

PAPER TAPE READER INSTRUCTIONS

The Paper Tape Reader instructions are designed to function both as "read" instructions and as "keyboard" instructions.

When all tape reading conditions exist, i.e., the reader is on, the photo-electric light is on, and media is present, reading of the paper tape will occur according to the specifications of the instruction.

If any of the above conditions do not exist, then the reader is not operable (a "reader condition" has occurred). The read instruction now reverts to its keyboard counterpart**, and the keyboard buffer is cleared so that the operator may now manually index that data required by the altered read instruction. Note that any data resident in the keyboard buffer is lost when the read instruction fails to execute. It follows that the reader instruction must be reached before a manual entry is made in its place. Because if the operator anticipates this condition and indexes data before the program halts, the data will be lost.

The mnemonic representations of the read instructions are the same as selected keyboard instructions with the addition of a prefix letter "R."

Instructions that involve punching paper tape along with reading of paper tape will inhibit the punch part of the instruction if the tape perforator is turned off. In addition, the Punch Off Indicator light is turned on and Punch Off Flag is set (refer to Page 2-95).

***The user should set the mode of transmission after firmware is loaded into the machine. The mode only needs to be set once; thereafter, unless firmware is reloaded, the mode will remain the same until set by another LTF instruction.**

****EXCEPTION: RNK reverts to a NKRCM (see Page 2-4).**

RTK
RTKM
REAM (PT)

PAPER TAPE/EDGE PUNCHED CARD INPUT INSTRUCTIONS

Read Alphanumeric Data and Print Instruction

	OP CODE	A
READ ALPHA AND PRINT	RTK	0-150 15" forms transport
	RTK	0-255 26" forms transport

The RTK instruction reads from tape (i.e., paper tape or edge punched card) and prints the number of alphanumeric characters specified by the "A" field. The instruction will be terminated upon reading a field identifier code or upon completion of reading the number of alphanumeric characters as denoted by the "A" parameter.

The flag patterns to be set by the field identifier codes are determined by the Table of Input Code Assignments (see Appendix I).

When a "reader condition" exists, the RTK instruction reverts to a TK instruction and the keyboard buffer is CLEARED in anticipation of manual input.

Read Alphanumeric Data into Memory and Print Instruction

	OP CODE	A
READ ALPHA INTO MEMORY AND PRINT	RTKM	0-150 15" forms transport
	RTKM	0-255 26" forms transport

The RTKM instruction reads from tape into memory and prints the number of alphanumeric characters specified by the "A" field. The RTKM should be preceded by an LKBR instruction to indicate the starting word location in memory for character storage. (See 2-9.)

The word of entry is incremented to the next higher word after each eight characters have been read. The instruction will be terminated upon reading a field identifier code or completion of reading the number of alphanumeric characters specified in the "A" field. The flag patterns to be set by the field identifier codes are determined by the table of input code assignments. (See Appendix I).

If a reader condition exists, the RTKM instruction will revert to a TKM instruction. (See RTK instruction).

Read Alphanumeric into Memory with Non-print Instruction

	OP CODE	A
READ ALPHA INTO MEMORY, NON-PRINT	REAM	0-150 15" forms transport
	REAM	0-255 26" forms transport

The REAM instruction reads from tape into memory the number of alphanumeric characters specified in the "A" parameter; no printing occurs. The REAM instruction should be preceded by an LKBR instruction to denote the starting word location in memory for character storage. The word of entry is incremented to the next higher order word after each set of eight characters has been read. The instruction will be terminated upon reading a field identifier code or completion of reading the number of alphanumeric characters specified in the "A" field. The flag patterns to be set by the field identifier codes are determined by the Table of Input Code Assignments.

RXTK
RXTKM
RNK (PT)

If a reader condition exists, the REAM instruction reverts to an EAM instruction. (See RTK instruction).

Read Alphanumeric Data, Print and Punch Instruction

	OP CODE	A
READ ALPHA, PRINT AND PUNCH	RXTK	0-150 15" forms transport
	RXTK	0-255 26" forms transport

The RXTK instruction reads from tape, and simultaneously prints and punches the number of characters specified in the A parameter. The instruction is terminated after reading the specified number of characters or upon reading a field identifier code.

The flag patterns to be set by the field identifier codes are determined by the Table of Input Assignments. (See table in Appendix I).

The RXTK instruction can revert to an XTK instruction if the tape reader is not operable. If the paper tape punch is off, the RXTK will revert to a RTK instruction; or to a TK instruction if both a reader and perforator condition exist. (See RTK instruction).

Read Alphanumeric Data into Memory with Print and Punch Instruction

	OP CODE	A
READ ALPHA INTO MEMORY, PRINT AND PUNCH	RXTKM	0-150 15" forms transport
	RXTKM	0-255 26" forms transport

The RXTKM instruction is the same as the RTKM instruction, except that tape punching occurs simultaneously.

The RXTKM instruction can revert to an XTKM instruction if the tape reader is not operable. If a perforator condition exists, the RXTKM will revert to a RTKM instruction; or to a TKM instruction if both a reader and perforator condition exist.

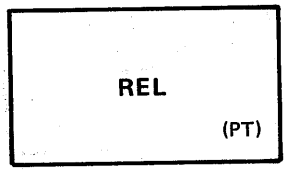
Read Numeric Data into Accumulator Instruction

	OP CODE	A	B
READ NUMERIC INTO ACCUMULATOR	RNK	0-15	0-15

The RNK instruction reads from the tape into the Accumulator the total number of characters specified by the sum (maximum of 15) of the A and B parameters. The instruction is terminated after the total number of characters specified have been read (fixed field) or upon reading a field identifier code (variable fields). The paper tape characters enter the Accumulator as digits, from low to high order digit positions. NOTE: No printing occurs.

A number may be read into the Accumulator as either a fixed field or a variable field.

With a fixed field, the tape must contain as many codes as the total number of digits required by the instruction. This may require that preceding zeros be included in the tape in order to obtain the fixed field size. Because the codes enter the low order position, reading a decimal number into the Accumulator requires that the maximum number of decimal places to the right of the decimal point be



filled with digits or zeros. Note that the separation of the fields into whole and decimal digits is provided to permit keyboard flexibility when a reader condition occurs (see use of NK, Page 2-4).

Example: Read 12.25 into the Accumulator, allow for 3 decimal places, fixed field of 9.

OP CODE	A	B
RNK	6	3

Tape must contain: 000012250 (no field I.D. code)

Manual entry must be: 12250 (left to right)

Manual entry format: 1, 2, decimal, 2, 5, and 0

Variable fields eliminate the "preceding zeros" requirement of fixed fields. Instead, a "field identifier code" immediately follows the number in the tape causing termination of the RNK. With variable fields, the A parameter must be 1 greater than the maximum digits allowed for that quantity so that the field identifier code may be read.

Example: Read 12.25 into the Accumulator, allow for 3 decimal places with maximum of 9 digits.

OP CODE	A	B
RNK	6+FS = 7	3

Tape contains 12250 FS (FS denotes field I.D. code)

Example: Read 4000 into the Accumulator. Maximum of 4 digits.

OP CODE	A	B
RNK	5	0

Tape contains 4000FS

Release Media Clamp Instruction

	OP CODE
RELEASE MEDIA CLAMP	REL

The REL instruction will cause the media clamp for paper tape or edge punched cards to open, thus halting any further reading until the operator places new material in the reader.

This instruction is useful when using edge punched cards, to release the card after necessary information has been read, and to prevent any additional information on the card from enabling the read instruction for the next entry.

OUTPUT WITH PAPER TAPE/EDGE PUNCHED CARD PERFORATOR

The instructions described in this section provide the means to output data into punched paper tape and/or edge punched cards by using a Style A 562 Paper Tape/Edge Punched Card Perforator as the output adjunct. All subsequent reference to "paper tape" applies both to punched paper tape and to edge punched cards, unless indicated otherwise.

Tape punching is serial at a speed up to 40 characters per second when no printing accompanies it. When printing accompanies punching paper tape, the punching speed is up to 20 characters per second.

The Series L/TC internal character code is USASCII and output to paper tape will normally be in this code. However, any 5, 6, 7, or 8 channel paper tape code can be punched by utilizing a Table of Output Code Assignments for conversion of the internal code into a different paper tape code (refer to Appendix I). The firmware for 5 channel code is different than that for 6, 7, or 8 channel "table look-up" firmware or for USASCII No Table firmware.

The Paper Tape Punch Instructions provide the ability to print and punch data from the Accumulator, print and punch alphanumeric data from memory, and to type or type into memory while punching. In addition, a register is provided which counts the number of codes punched. This enables the use of continuous edge punched cards by making it possible to determine when one continuous card has been filled or when to fill any unused portion of a continuous card with feed codes before aligning the next continuous card to the first sprocket hole.

The Paper Tape Punch Instructions are designed to function in three ways:

1. When proper tape punching conditions exist, punching will occur according to the specifications of the instruction.
2. If the perforator is not connected or is turned off, the punch portion of the instruction is inhibited and the instruction is executed in accordance with its counterpart keyboard or print instruction. Thus, although the program may provide for punching, the perforator may be turned off or discontinued without affecting the operation of the rest of the system.
3. If the perforator is turned on but does not have media loaded, execution of the punch instruction is held up until the condition is corrected.

The mnemonic representations of the punch instructions are the same as selected keyboard and print instructions with the addition of a prefix letter "X."

PAPER TAPE/EDGE PUNCHED CARD OUTPUT INSTRUCTIONS

Type, Punch and Print Instruction

	OP CODE	A
TYPE, PUNCH	XTK	0-150 15" forms transport
	XTK	0-255 26" forms transport

The XTK instruction allows typing, printing and punching up to the number of characters specified in the A field. The instruction functions like a TK instruction except that punching occurs with it. The termination of this instruction with an OCK or PK does not cause a code to punch.

XTKM
XEAM
XPA
XA (PT)

If the perforator is turned off or disconnected, the XTK instruction will operate only as a TK instruction.

Type into Memory, Print and Punch Instruction

	OP CODE	A
TYPE INTO MEMORY, PUNCH AND PRINT	XTKM	0-150 15" forms transport
	XTKM	0-255 26" forms transport

The XTKM instruction allows typing into memory, printing and punching up to the maximum number of characters specified in the A field. This instruction should be used in conjunction with the LKBR instruction to denote the entry position in memory for the characters typed. (See Page 2-9.)

The XTKM instruction functions like a TKM instruction except that punching also occurs. The termination of this instruction with an OCK or PK places an End Alpha code in memory but does not cause a code punch.

If the perforator is turned off, or disconnected, the XTKM instruction functions as a TKM instruction.

Enter into Memory and Punch Instructions

	OP CODE	A
ENTER INTO MEMORY AND PUNCH	XEAM	0-150 15" forms transport
	XEAM	0-255 26" forms transport

The XEAM instruction functions exactly like the XTKM instruction except that printing does not occur. If the perforator is turned off, or disconnected, XEAM will operate only as an EAM instruction.

Print Alpha and Punch Instruction

	OP CODE	A
PRINT ALPHA AND PUNCH	XPA	LABEL

The XPA instruction prints and punches the alphanumeric data stored in the memory location designated by the A field. The instruction is terminated upon reaching an End of Alpha code in the data; the End of Alpha code is not punched. This instruction operates like a PA instruction in every respect except that punching occurs.

With the perforator turned off or disconnected, the XPA will operate as a PA instruction.

Punch Alpha from Memory, Non-print Instruction

	OP CODE	A
PUNCH ALPHA FROM MEMORY, NON-PRINT	XA	LABEL

The XA instruction functions exactly as an XPA instruction except that printing does not occur.

If the perforator is turned off or disconnected, the XA functions as a No Operation (NOP) instruction.

XC
XPN (PT)

Punch Special Code Instruction

	OP CODE	A	B
PUNCH CODE	XC	0-15	0-15

The XC instruction punches into tape the bit pattern specified by the parameter fields. The A parameter indicates the decimal value of the high order 4 bits (b_8, b_7, b_6, b_5, having decimal values of 8, 4, 2, 1 respectively); the B parameter represents the decimal value of the low order 4 bits (b_4, b_3, b_2, b_1, having decimal values of 8, 4, 2, 1 respectively) in the bit configuration of the desired code. The parity bit must be included in the appropriate bit position when applicable.

In the case of USASCII code the column number of the desired code in the table represents the A field (parity bit must be added when applicable); the row number of the desired code represents the B field.

Printing does not occur with this instruction. If the perforator is turned off or disconnected, the XC will function as a "No Operation" (NOP) instruction.

Example: Punch the USASCII code "RS"

	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Bit pattern ("X" = hole in tape)	0	0	0	X	X	X	X	0
Decimal value	8	4	2	1	8	4	2	1
Parameter value	A = (0+0+0+1) = 1							
	B = (8+4+2) = 14							

This corresponds to the USASCII table location of RS in column 1, row 14.

Print and Punch Numeric Instruction

	OP CODE	A	B
PRINT AND PUNCH NUMERIC	XPN	0-14	0-15

The XPN instruction prints and punches the contents of the Accumulator, beginning with the high order digit position specified in the A parameter and with the print mask designated by the B parameter. The print mask is relative to the mask table established by the last LPNR instruction. (See 2-12.)

There will be no affect on the Accumulator flags position or any other data in Accumulator positions to the left of the digit position specified by the A parameter.

This instruction functions like the PN instruction except that punching occurs.

If the perforator is turned off, or disconnected, the XPN instruction will operate only as a PN instruction.

XPNS–	XPNS+
XN	
LXC	
XMOD (PT)	

Print and Punch Numeric Data, Shift Ribbon Instructions

	OP CODE	A	B
PRINT AND PUNCH NUMERIC, SHIFT RIBBON IF MINUS	XPNS–	0-14	0-14
PRINT AND PUNCH NUMERIC, SHIFT RIBBON IF PLUS	XPNS+	0-14	0-15

The XPNS– instruction is the same as the XPN instruction except that the ribbon color is changed if the Accumulator Sign Flag is set (minus).

The XPNS+ instruction is the same as the XPN instruction except that the ribbon color is changed (opposite to the normal operating color of black, is red) if the Accumulator Sign Flag is reset (plus).

If the perforator is turned off or disconnected, the XPNS– and XPNS+ function as PNS– and PNS+ instructions respectively.

Punch Numeric Data, Non-print

	OP CODE	A	B
PUNCH NUMERIC, NON-PRINT	XN	0-14	0-15

The XN instruction is the same as the XPN instruction except that printing does not occur. A mask word is used with this instruction since it controls the punching. (See 2-14.) The mask word selected may be the same as is used with other Print Numeric Instructions since it would not affect the non-print function of this instruction.

If the perforator is turned off or disconnected, the XN will operate as a "No Operation" (NOP) instruction.

Load Punch Count Register Instruction

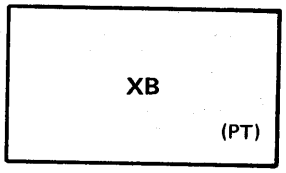
	OP CODE	A
LOAD PUNCH COUNT REGISTER	LXC	0-255

The Punch Count Register is provided to count the number of holes punched. This enables the use of continuous edge punched cards by making it possible to determine when one edge punched card has been filled or to fill any unused portion of a continuous card with feed codes before aligning the next continuous card to the first sprocket hole.

The LXC instruction will load the number contained in the A field, into the punch count register. The instruction is normally used at the start of each new continuous edge punched card to reset the count. The punch count register is incremented by one for each code punched from any punching instruction. If the register is equal to 255, incrementing causes the register to become 0.

Modify by Punch Count Register Instruction

	OP CODE
MODIFY BY PUNCH COUNT REGISTER	XMOD



The XMOD instruction will modify the parameter field of the next instruction by the contents of the punch count register. This modification occurs as in the MOD instruction. The XMOD cannot be changed by the Index Register instructions. (i.e., IIR, ADIR, etc.)

Punching Feed Codes Instructions

	OP CODE	A
PUNCH FEED CODES	XB	0-255

The XB instruction causes feed (sprocket) holes to be punched. The number of codes punched will be the difference between the number in the A field and 255.

If the perforator is turned off, XB will operate as a "No Operation" (NOP) instruction.

When edge punched cards are the media present, punching of sprocket holes is inhibited. Therefore, the card is just advanced without sprocket hole punching.

READER AND PUNCH FLAGS

Reader Flags

Two reader flags are provided to enable program control over the tape reader.

Reader flag R1 is set when a reader condition exists. A reader condition exists if any of these contingencies arise:

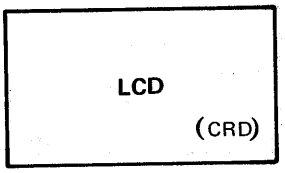
1. The Paper Tape Reader is not turned on.
2. Media (paper tape or an edge punched card must be positioned in the reader).
3. The media clamp must be closed.
4. The photo-electric device must be illuminated.

When the reader condition exists, along with the R1 flag being set, the keyboard buffer is cleared, and the instruction is held up from execution pending operator action. The action depends on two conditions:

1. The reader is intended to be used: Turn on the reader and then depress the Read Key. This reinitiates the read instruction and causes the media to be read. The R1 flag is reset.
2. The reader is not intended to be used: The operator may make an entry through the keyboard. (At this point, remember, the reader instruction has reverted to its keyboard instruction). The Reset Key will reinitiate the tape read instruction, but it must be indexed prior to the use of an OCK or PK.

Once the operator has taken either course of action, the indicator light is turned off and reader flag R1 is reset.

NOTE: The keyboard buffer is cleared every time a reader instruction reverts to its keyboard counterpart. If the operator has anticipated this and indexed data prior to the halt in the program when the reader instruction becomes a keyboard instruction, then that data will be lost. The operator would have to index the data again.



Reader flags R2, R3 are reserved for Data Communication operations. (See 2-62.)

Reader Flag R4 is set when an invalid tape code is read. Reading is not halted on the invalid tape code. The next read instruction will reset the R4 flag.

The Reader flag settings can be manipulated by use of the Flag instructions.

Punch Flags

Four Punch Flags are provided to alert the operator of the perforator condition.

The Punch Flag P1 is set if media is not present in the perforator and the program attempts to execute a punch instruction. The instruction is halted. Correction of the situation will cause the system to resume execution of the punch instruction.

The Punch flag P2 is set if incorrect punching has occurred during a punch instruction. The echo check indicator light is lit. The punching is not terminated; the flag remains set.

The program should provide for checking flag P2 at least after each line of punching. When the flag is set, a Skip or Execute instruction would enable performing the necessary instruction to sound the alarm, punch a tape error code, or to take other corrective action.

The Punch flag P3 is set if reel tape is being used and the supply is nearly exhausted (approximately 20 feet remaining). The Tape Supply indicator is lit. Placing a new roll of tape in the supply reel will turn off the indicator and reset the flag on the next punch instruction. This condition does not halt program execution nor inhibit punching.

The Punch Flag P4 is set if the paper tape perforator is "OFF." The instruction will be executed, but the punching will be inhibited. Switching the perforator to the "ON" condition causes the P4 flag to be reset on the next instruction. However, the data to be punched on the first "punch" instruction would be missing from the output tape. Therefore, it is recommended that a punch instruction be used during the program initialization routine with subsequent testing of the Punch Flags (especially the P4 flag) since the perforator condition is only apparent once a punch instruction is initiated. All punch flags may be examined by use of the flag instructions.

80-COLUMN PUNCHED CARD INSTRUCTIONS

With the A 595 Card Reader and the A 142 Card Punch used as peripherals to either the Series L or TC 500, 80-column punched cards can be used as input and 80-column punched cards can be punched as output. The programing instructions required to use these two peripherals as part of a program will be explained in two sections. The first section will deal with card input instructions, the second will explain card output instructions.

80-COLUMN CARD INPUT INSTRUCTIONS

Read Object Program Cards

	OP CODE	A	B
LOAD MEMORY FROM CARD	LCD	0-255	

RCD
LCFR (CRD)

The LCD instruction causes the reading of object program cards and stores the new object program instructions into memory locations specified in the program cards. The A parameter specifies the number of cards to be read. This instruction utilizes and requires that the Card Reader Memory Load Routine be present in the Utility Track.

LCD allows programmatic control of program overlays. After reading the designated number of program cards, the program execution continues on to the next instruction in accordance with the program counter. Thus, caution must be exercised to ensure that a program does not overlay the same memory area occupied by the LCD instruction. The program cards must be of the same format as required for regular program loading with the Card Reader. (Refer to Section 6 Object Program Loading, for card format required to load object program by card.)

After execution of this instruction, a "Hash Total" of the program data read in, is in the Accumulator.

If the specified number of program cards are not read, the instruction is held up, the Reader Condition light is turned on and the R1 flag is set.

Placing the remaining cards to read in the Card Reader and depressing the Restart switch on the Card Reader, or depressing the Ready push button to return the machine to Ready mode, are the only two alternatives available to complete the LCD instruction.

Reading Punched Cards

	OP CODE	A	B
READ CARD	RCD		

The RCD instruction reads a single 80-column punched card into words 1 through 10 of memory. All 80 columns are read and placed in memory including blank card columns.

During the execution of each RCD instruction, the contents of the Accumulator are destroyed and the Accumulator is not cleared. Any number in the Accumulator prior to a RCD instruction which is to be used later in the program, should be transferred to a memory location to save it, else it will be destroyed in the Accumulator.

If a card is not present in the Card Reader, when a RCD instruction is to be executed, the Reader Condition indicator light is turned on, flag R1 is set, and the instruction is held up.

Placing a card in the Card Reader and depressing the Restart switch on the Card Reader will enable the instruction to be completed and allow the program to continue to the next instruction. The other alternative would be to depress the Ready push button, to return the machine to Ready mode.

Defining Card Field Formats

	OP CODE	A	B
LOAD CARD FORMAT REGISTER	LCFR	LABEL	

PBA
XPBA (CRD)

The LCFR instruction loads into the Card Format Register the word number associated with the Label name. A Card Format Table may contain up to 16 different card field formats. If more than 16 are required, another table location (i.e., another LCFR instruction with a different label) must be established before any formats can be referenced in the second table. Only one table can be referenced at one time, and that table referenced is dependent upon the last LCFR instruction.

The label in the A parameter must reference the beginning of a word. The Pseudo Instruction "WORD" should be used preceding the label of the first CDF pseudo instruction, so that it starts at the beginning of a word.

Example:

LABEL	OP CODE	A	B
	LCFR	CRDTAB	
	WORD		
CRDTAB	CDF	1	2
	CDF	3	5

Printing Alphanumeric Data from Card Read Area

	OP CODE	A	B
PRINT ALPHA FROM CARD READ AREA	PBA	1-16	

The PBA instruction prints from the card read area, the field, specified by the format number, as alphanumeric data.

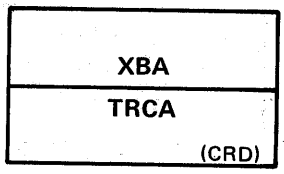
The format number, references the format table last identified by the LCFR instruction.

Example:

LABEL	OP CODE	A	B	REMARKS
	LCFR	CRDTAB		
	PBA	2		Print second field on card.
	NOTE			Card cols. 3-10
CRDTAB	CDF	1	2	Card cols. 1-2
	CDF	3	8	Card cols. 3-10

Printing and Punching Alphanumeric Data from the Card Read Area

	OP CODE	A	B
PRINT & PUNCH ALPHA FROM CARD READ AREA	XPBA	1-16	



The XPBA instruction prints from the card read area, the field specified by the format number, as alphanumeric data, and punches the data into an output card in the A 142 Card Punch. The instruction is terminated after printing and punching the number of characters specified by the field length in the format. The status of OCK flags is not affected.

If the Punch is off, XPBA is executed as a PBA instruction.

If there are no cards in the card hopper and the Punch is on and on-line, the XPBA instruction will be held up until cards are placed in the card hopper and the auto feed button depressed on the Punch.

Punching Alphanumeric Data from the Card Read Area, Non-printing

	OP CODE	A	B
PUNCH ALPHA FROM CARD READ AREA, NON-PRINT	XBA	1-16	

The XBA instruction punches into an output card, from the card read area, the field specified by the format number, as alphanumeric data. The data is not printed. The instruction is terminated after punching the number of characters specified by the field length in the format.

If the Punch is off, XBA is executed as a NOP instruction.

If no cards are in the card hopper and the Punch is on card on-line, the XBA instruction will be held up until cards are placed in the card hopper and the auto feed button depressed on the Punch.

Transferring Card Input Data to the Accumulator as Numeric Data

	OP CODE	A	B
TRANSFER CARD FIELD TO ACCUMULATOR AS NUMERIC	TRCA	1-16	

The TRCA instruction transfers the field of data, specified by the format number in the A parameter, from the Card Read Area into the Accumulator. The digits in that field are right justified when transferred into the Accumulator. The instruction is terminated by transferring the number of card columns specified in the format. The status of the OCK flags is not changed by this instruction.

If an "11" overpunch is present in any of the card columns of the field being transferred (denoting a negative field), the Minus Flag in the Accumulator is set.

If a "12" or "0" overpunch is present in any of the card columns of the field being transferred, the Invalid Code Flag (R4) and the corresponding indicator light is turned on if the lower 4 bits are anything other than 0, and a digit will be transferred to the Accumulator. The flag is reset and the indicator is turned off at the beginning of the next Card Input Transfer instruction; therefore, this flag must be examined immediately in the program (with the SK or EX instructions) when it is necessary to detect illegal codes in a given field. The characters "+" (card codes 12,0) and "&" (card code 12) will not affect the Minus flag nor set the Invalid Code flag, but will transfer as the digit "0" in accordance with their position in the field. The hyphen character (minus sign) "–" (card code 11) and "X" (minus zero – card code 11,0) set the Minus flag, do not set the Invalid Code flag, and are transferred as the

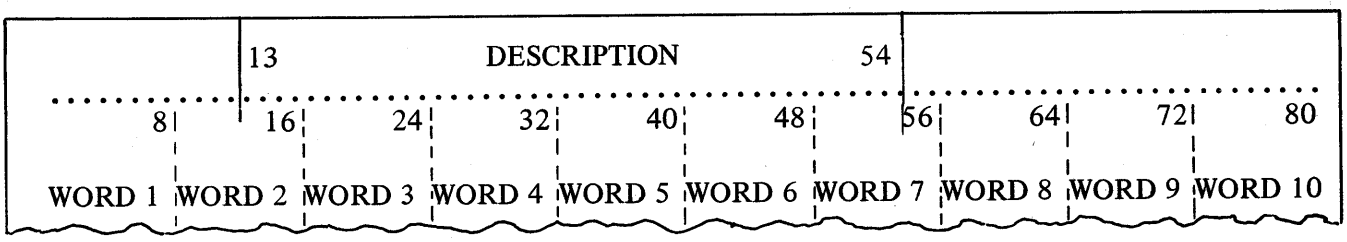
digit "0" in accordance with their position in the field. The letters A through I and S through Z, as well as all other special characters, will set the Invalid Code flag and a digit transferred. The letters J through R are the same as numerals with an "11" overpunch. The space code (blank card column) is treated as the numeral "0."

An invalid code can be used to advantage to indicate special conditions, such as the last card in an input file. For example, a "12" overpunch with a transaction type number would permit the program to determine when to stop reading cards. This would not require a separate card column for this purpose, and would not affect the usability of the transaction number.

Example of Printing Alpha Data from the Card Read Area

The programing below is an example of minimizing the length of alpha print time by examining certain positions of a description field in the card read area to determine the amount of significant data, and selecting a field format length accordingly; thereby eliminating some of the trailing space codes in the unused portion of the field when printing or transferring to memory.

The diagram below illustrates a card with a description field of 42 characters (col's. 13 to 54). On the premise that most descriptions are less than 21 characters, some are less than 29, only a few use the maximum field capacity, and that no more than 6 consecutive space codes are permitted within the description, then three formats are defined for the description field to permit the program to select the shortest length; thus, considerably reducing print time and/or transfer time (42 characters require approximately 2100 ms print time vs. approximately 1000 ms using a 20 character length format).



LABEL	INSTR	A	B	REMARKS
FIELDS	CDF	13	20	SHORT DESCRIPTION
	CDF	13	28	MEDIUM DESCRIPTION
	CDF	13	42	MAXIMUM DESCRIPTION

For simplest programing, the positions in the field to be examined for space codes must be defined taking into account the word boundaries of the card read area. The 21st through 28th positions in the description field are card columns 32 to 40 and are in word 5 (base word +4). If word 5 contains all zeros (8 space codes), then significant data is presumed to not extend beyond col. 32 (20th field position). If word 5 contains any significance, then word 6 is examined. If word 6 has all zeros, then data does not extend beyond col. 40 (28th position). If word 6 contains data, the infrequency of occurrence suggests that no further tests should be made and a maximum field size is used. The card read area is reserved with REG instead of CDB to permit a label for referencing specific words.

Program Segments:

```
                LABEL     INSTR     A          B      REMARKS
                START     LPNR      PMASKS
                          LPKR      PKEYS
                          LLLR      51
                          BRU       BEGIN
                CARDIN    REG       10               RESERVE CARD READ AREA
                BEGIN     ____                       Note that Card Read area is reserved
                          ____                       with REG to permit labeling; but
                          ____                       must be sequenced to assure assem-
                                                     bly in words 1-10.
                          RCD                        READ A CARD
                          LCFR      FIELDS           SELECT FORMAT TABLE
                          LKBR      DESCRP           SELECT DESCRIP TANK
                          TRA       CARDIN + 4       READ COLS 33 TO 40
                          SLROS     0          2     MOVE FLAG POSITION
                          EXZ       3                EXAMINE FOR SPACES
a                         PBA       1                PRINT SHORT FIELD
a                         TRCM      1                TRANSFER SHORT FLD
a                         BRU       + 9
  b c                     TRA       CARDIN + 5       READ COLS 41 TO 48
  b c                     SLROS     0          2     MOVE FLAG POSITION
  b c                     EXZ       2                EXAMINE FOR SPACES
  b                       PBA       2                PRINT MEDIUM FIELD
  b                       TRCM      2                TRANSFER MED FLD
  b c                     SKZ       2                EXAMINE FOR DATA
    c                     PBA       3                PRINT LONG FIELD
    c                     TRCM      3                TRANSFER LONG FLD
                DESCRP    REG       6                DESCRIPTION WORK AREA
```

Note: The key along the left margin indicates the program path selected depending on field size; "a" = short field, "b" = medium field, "c" = long field. Statements without a key are executed by all three paths.

TRCM

(CRD)

Transferring Alphanumeric Data from the Card Read Area to Memory

	OP CODE	A	B
TRANSFER CARD COLUMNS TO MEMORY AS ALPHA	TRCM	1-16	

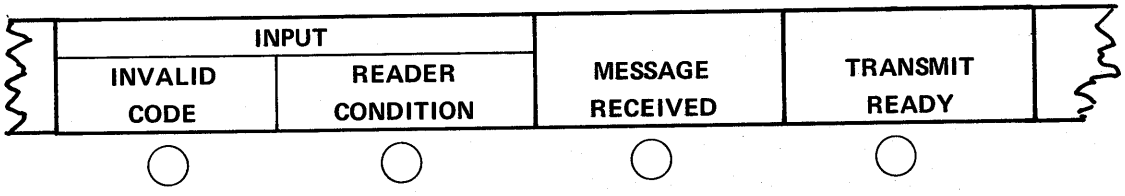
The TRCM instruction transfers the field specified by the format number in the A parameter to a memory location starting with the word designated by the prior use of the LKBR instruction. The instruction is terminated after transferring the number of characters specified by the field length in the format. An "End of Alpha" code is placed in memory following the last code transferred. The status of OCK flags is not affected.

Space codes (blank columns) are transferred and translated as Space Codes; in subsequent printing of this data from memory (not the card read area) with the PA instruction, the space characters will cause the printer to escape rather than increment the position register. This condition would be common in the unused portion of a description field such as name or address, when the card input data has to be retained for further processing while additional cards are being read. Escaping through space codes can be reduced, by programmatically examining certain points in the card read field and using a smaller field format when transferring the field to memory. This may be desirable when the field must be designed with a large capacity to accommodate all transactions, but which may have many transactions with small entries of data (see example, above).

An indication of Invalid Code is not provided if an incorrect combination of punches has been read into the Card Read Area. Invalid Code indication is only included with the TRCA instruction.

Input Indicator Lights and Flags

The two Series L keyboard input indicator lights advise the operator as to whether the Card Reader is operable, and, under certain conditions, whether invalid codes have been read. Also, the associated Reader flags enable the program to provide alternate procedures in the event of a Reader Condition or invalid code.



Input Indicator Lights

INVALID CODE INDICATOR – The Invalid Code Indicator is turned on and its associated flag (R4) is set, when, during the execution of the TRCA (Transfer to Accumulator) instruction, a code is sensed that represents an invalid combination as described in the TRCA instruction. This flag is reset and the Indicator turned off at the beginning of the next transfer instruction.

READER CONDITION INDICATOR – The Reader Condition Indicator is illuminated and flag R1 set when a card read instruction (RCD) is being executed and any of the following conditions exist:

1. The reader is not on
2. The reader is out of cards
3. Burned out bulb in reader

The read instruction is held up pending operator action as follows:

1. If the Reader is out of cards, the placing of cards in the feed hopper and depression of the Restart Switch on the reader will then cause the card read instruction to be executed.
2. If the Reader is not on, the Reader power on switch must first be turned on and then the Restart momentary switch depressed.
3. The use of the Ready push button, at this point will return the program to the READY mode.

The R1 flag is set only while waiting to read a card, and is reset when the instruction is executed. Therefore, only the Indicator light can be used to notify the operator of this condition.

The R2 and R3 flags are set or reset by Data Comm instructions and are not controlled by card instructions. See page 2-62.

FLAG INSTRUCTIONS (LOAD, SET, RESET, CHANGE) – The execution of a LOD, SET, RST, or CHG Flag instruction involving the Reader Flags will also cause their associated indicator lights to either be turned on or off depending on the instruction used.

Program Keys

Program Keys that have been enabled prior to a Card Read instruction or any of the Card Transfer instructions will be ignored during those instructions. If a Reader Condition occurs and the Card Read instruction is held up, use of a PK will have no immediate affect except to place the PK code in the keyboard buffer pending the next keyboard instruction where it will be recognized.

80-COLUMN CARD OUTPUT INSTRUCTIONS

Punching Alphanumeric Data

The following instructions provide for punching alphanumeric data during keyboard entry or directly from storage in memory. Each use of one of these instructions punches one field, or a portion thereof, depending on the number of characters and the field size. Therefore the SKP (see page 2-109) instruction should normally be used following each of these instructions to by-pass unused trailing positions in the field and to position the card to the first column in the next field.

Type and Punch

	OP CODE	A
TYPE AND PUNCH	XTK	0-150 15" forms transport
	XTK	0-255 26" forms transport

XTKM
XEAM
XPA (CRD)

The XTK instruction combines typing, printing and punching up to the maximum number of characters specified in the A parameter. This instruction functions like a TK instruction in most respects with the additional function of punching the data into an 80-column card. However, the use of the Backspace Key is disabled, since a code would already have punched. The termination of this instruction with an OCK or PK does not cause a code to punch.

If the punch is off-line, XTK will be executed only as a TK instruction.

The use of the Backspace Key has been prohibited; therefore, if it is depressed, an error state occurs which requires depression of the Reset Key. Caution must be exercised with use of the Reset Key since, if in the middle of a keyboard entry but not in an error state, use of the Reset Key re-initiates the instruction and sets the LXC Register back to the start of the field. This puts the card out of step since part of the field has already punched. These considerations also apply to XTKM and XEAM following.

Type into Memory Punch and Print

	OP CODE	A
TYPE INTO MEMORY, PUNCH AND PRINT	XTKM	0-150 15" forms transport
	XTKM	0-255 26" forms transport

The XTKM instruction combines typing, printing, entering the data into memory and punching up to the maximum number of characters specified in the A parameter. The prior use of LKBR designates the starting word for storing the data. The XTKM instruction functions like the TKM instruction in every respect with the additional function of punching into an 80-column card. However, the use of the Backspace Key is disabled (see XTK) since a code would already have punched. The termination of this instruction with an OCK or PK does not cause a code to punch, but does place an End of Alpha code in memory.

If the Punch is off-line, XTKM is executed only as a TKM instruction.

Entering Alpha into Memory and Punch Non-print

	OP CODE	A
ENTER ALPHA INTO MEMORY AND PUNCH, NON-PRINT	XEAM	0-150 15" forms transport
	XEAM	0-255 26" forms transport

The XEAM instruction functions exactly like the XTKM instruction except that printing does not occur. If the Punch is off-line, XEAM is executed only as an EAM instruction.

Print Alpha from Memory and Punch

	OP CODE	A	B
PRINT ALPHA AND PUNCH	XPA	LABEL	

The XPA instruction prints and punches the alphanumeric data stored in the memory location designated by the A parameter. The instruction is terminated upon reaching an End of Alpha code in the data; the End of Alpha code does not punch. This instruction functions like a PA instruction in

every respect with the additional function of punching into an 80-column card. If the Punch is off-line, the XPA instruction is executed only as a PA instruction.

Punch Alpha from Memory, Non-print

	OP CODE	A	B
PUNCH ALPHA FROM MEMORY, NON-PRINT	XA	LABEL	

The XA instruction functions exactly like the XPA instruction except that printing does not occur. If the Punch is off-line, XA is executed as a NOP instruction.

Punching Numeric Data from the Accumulator

The following instructions provide for printing and punching, or just punching, numeric data from the Accumulator. The Pointer designates the high order digit position of the Accumulator at which printing and punching begin; the printing format and punching are controlled by the Mask word selected. The instruction is terminated after punching and printing through digit position zero or when an "E" (End) Mask code is encountered in the Mask word. A Mask word is used for all punch numeric instructions even though printing may not be a function of a given instruction. It serves to right justify the numeric data in the card field, filling in preceding zeros or blank columns. Therefore, a fixed field length results and the use of SKP subsequently is not needed.

The Punch Flag (P) in the Mask word, when set, causes leading zeros to punch even though leading zero suppression Mask codes (Z,Z) prevent their printing. If the Punch Flag is not set, a blank card column results for each leading zero suppressed by a Z (or Z,) Mask code; however, if the Punch Flag is not set and if an Unconditional Print Mask code is used (D D, etc.), all leading zeros will punch into the card (refer to the following table). The Punch Flag has no effect on the print characteristics of the Mask codes.

Print and Punch Characteristics of Mask Codes

MASK CODE	PRINTING	PUNCHING
F	Print $	No Effect
+	Suppress Punctuation	No Effect
P	No Effect	Leading zeros punch if P flag set, blank card column if reset
D D, .D D:	Print Character regardless of significance	Punch Character regardless of significance
X .X	Trailing zero suppression	
C .C	Leading zero & trailing zero suppression	
Z Z, Z:	Print if: (1) Accum digit not zero (2) A non-zero digit has been printed	Punch if: (1) P is Set (2) Accum digit not zero (3) A non-zero digit has been punched
S	Print only if Accum digit not zero	
I	Ignore	Ignore
E	Terminate, Non-print	Terminate, Non-punch

TABLE

If an Ignore (I) Mask code is used, the corresponding digit in the Accumulator does not print or punch. If the End (E) Mask code is used, the corresponding digit neither prints nor punches and the instruction is terminated. All other Mask codes cause the corresponding digit to punch.

The punctuation provided by some of the Mask codes during printing does not punch.

XPN
XPNS–
XPNS+ (CRD)

In a numeric field on the output card, if only significant digits are to be interpreted along the top of the card, then leading zeros of the numeric word in the Accumulator must be represented by blank card columns in the output card (P Flag must be reset and "Z" mask codes used in order for this to occur).

Print and Punch Numeric Data

	OP CODE	A	B
PRINT & PUNCH NUMERIC	XPN	0-14	0-15

The XPN instruction prints and punches the contents of the Accumulator, starting at the high order digit position designated by the A parameter, in accordance with the print mask designated by the B parameter. The print mask value is relative to the mask table base word established by the last LPNR instruction. This instruction functions like a PN instruction in every respect with the additional function of punching.

If the Accumulator Minus Flag is set, an "11" overpunch is punched with the least significant digit of the Accumulator (digit 0); if minus, and if the mask word terminates printing/punching prior to digit 0, (with an "E") or ignores digit 0 (with an "I"), and "11" overpunch does not punch. If the "11" overpunch is not desired in the field, the Minus flag must first be reset.

All Accumulator digits of a higher order position than the A parameter are ignored.

When it is necessary to punch a plus "+" or minus "–" sign into a separate card column, or when the value of the other Accumulator flags (S, C, M) must be punched, this can be accomplished by testing the individual flag settings (SK or EX) and punching an appropriate code in the card column(s) with the XC (Punch Code) instruction prior to or after punching the numeric field with the XPN instruction. If the sign column must follow the numeric field, a set Minus flag must first be reset before punching the data; this usually requires separate program paths, after testing for a minus condition, to both punch the data and punch the correct sign code.

If the Punch is off-line, XPN is executed only as a PN instruction.

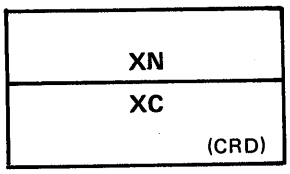
Ribbon Shift Print and Punch Numeric Data, Shift Ribbon if Minus

	OP CODE	A	B
PRINT & PUNCH NUMERIC, SHIFT RIBBON IF MINUS	XPNS–	0-14	0-15

The XPNS– instruction is the same as the XPN instruction except that the ribbon color is changed if the Accumulator Sign Flag is set (Minus). If the Punch is off-line, XPNS– is executed only as a PNS– instruction.

Print and Punch Numeric Data, Shift Ribbon if Plus

	OP CODE	A	B
PRINT & PUNCH NUMERIC, SHIFT RIBBON IF PLUS	XPNS+	0-14	0-15



The XPNS+ instruction is the same as the XPN instruction except that the ribbon color is changed if the Accumulator Sign Flag is reset (Plus). If the punch is off-line, XPNS+ is executed only as a PNS+ instruction.

Punch Numeric Data, Non-print

	OP CODE	A	B
PUNCH NUMERIC, NON-PRINT	XN	0-14	0-15

The XN instruction is the same as the XPN instruction except that no printing occurs. A mask word is used with this instruction since it controls punching, and may be the same mask word used with other Print Numeric instructions as there would be no affect on the non-print characteristic of XN. If the punch is off-line, XN is executed as a NOP instruction.

Other Card Output Instructions

The following instructions provide the ability to punch special codes in a card column, and give the program the ability to control the card for such functions as skipping or duplicating fields or portions of fields, releasing cards, and selecting the stacking hoppers.

Punching Special Codes

	OP CODE	A	B
PUNCH CODE	XC	0-15	0-15

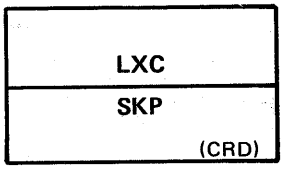
The XC instruction permits outputting any desired single card code (without it being resident in memory) or any special punch pattern in a card column (except only one punch can be created in rows 1 to 7 in a card column although any punch combination in the other rows can be obtained). The A parameter controls punching in card rows 12, 11, 0, and 9; the B parameter controls punching in card rows 1 through 8.

Printing does not occur with this instruction. If the Punch is off, XC is executed as a NOP instruction.

	ROWS 12, 11, 0, 9	ROWS 8, 1-7
A Parameter Value	8 4 2 1	
B Parameter Value		8 1-7

To punch an "A" (Row 12, 1) the XC instruction would be

OP CODE	A	B
XC	8	1



To punch Rows 12, 11, 0, 8, 6 the XC instruction would be

OP CODE	A	B
XC	14	14

Refer to Appendix H to find A and B parameter values of various characters to be punched.

CARD COLUMN SYNCHRONIZATION WITH THE PUNCH COUNT REGISTER

A Punch Count Register is used by firmware to count the card columns either punched or escaped in order to control the location of the card and maintain synchronization. When the system is turned on, the value in this register is indeterminable, and therefore it must be loaded with the value "1" at the start of a program.

Load Punch Count Register

	OP CODE	A	B
LOAD PUNCH COUNT REGISTER	LXC	1	

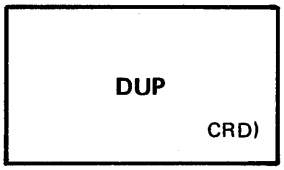
The LXC instruction loads the value specified in the A parameter into the Punch Count Register. The parameter value must be "1" to synchronize the register with the card in the punch station (card must be registered in the punch station at card column one).

The LXC instruction is normally used only once in a program, during the initialization routine. Once into the program, firmware resets the Punch Count Register to 1 whenever a card is released in the punch and another card registered at column 1. However, it is recommended that a provision be included in the program for the operator to reset the register to 1 in the event a card becomes out of step. This condition could occur from the improper use of the keyboard Reset Key during a keyboard entry, or from inadvertent manipulation of the control keys on the card punch (which should not be necessary once a program is in operation). Note that if the keyboard Reset Key is used during a keyboard entry and the system is not in an error state, the keyboard instruction is re-initiated (repositioning the printer and permitting a complete new entry) and the Punch Count Register is set back to the beginning column of that field; thus, the card must be backspaced to the same card column, using the Backspace control on the card punch, to regain synchronization.

Skipping Card Columns

	OP CODE	A	B
SKIP TO COLUMN	SKP	1-80	

The SKP instruction causes the card to skip to the card column specified in the A parameter. A skip to card column 1 causes the card to be released and a new card registered at column 1. This is the prescribed manner in which the Series L program releases a card. If the card is presently on the card column specified by the SKP instruction, no skipping occurs. An exception to this is a skip to 1 when the card is already on column 1; this results in the card being released and another card registered.



Once the skip function has been initiated, the program resumes execution while the skipping is being completed, except for skips of up to 3 columns. If the program reaches another punch instruction while skipping is occurring, the program is held up until skipping has been completed. Skips of 3 columns or less are actually treated as Punch Blanks (XC 0 0, blank card columns), and in this situation, program execution is held up until the skip is completed.

A skip to a lesser numbered column than the present card location will cause the release of the card and the registration of a new card; however, the count register will be in error for the newly registered card.

If the punch is off-line, the SKP instruction is executed as a NOP instruction.

The SKP instruction should normally be used after each punch instruction where unused card columns could remain, such as with XTK, XTKM, XPA, etc. It is normal for these instructions to be terminated before punching the total number of characters specified in the parameter; therefore, a SKP instruction must be used to ensure that the card is properly positioned to the start of the next field.

Duplicating Data from one Card to Another

	OP CODE	A	B
DUPLICATE THROUGH COLUMN	DUP	1-80	

The DUP instruction causes data from the card in the Read Station to be punched (duplicated) into the corresponding columns of the card in the punch station. The duplication function starts at and includes the card column at which it is initiated, and continues through the card column specified in the A parameter. A DUP through 80 will cause the card to be duplicated through column 80, released, and a new card registered at column 1. A DUP through the same card column number as the present location of the card results in no duplication.

Once the duplication function has been initiated, the program resumes execution while the duplication is being completed. If the program reaches another punch instruction while duplication is occurring, the program is held up until the duplication has been completed.

A DUP through a lesser numbered card column than the present location of the card will cause a duplication through column 80, release of the card and registration of a new card; however, the count register will be in error for the newly registered card.

If the punch is off-line, the DUP instruction is executed as a NOP instruction.

Card Release

Cards are released from the punch station by the Series L program with the use of a Skip to Column 1 instruction (SKP 1) or a Duplicate Through Column 80 instruction (DUP 80). Use of the card punch manual controls, during program operation, or any other type of program release will in most cases cause the newly registered card to be out of synchronization with the Punch Count Register.

Selection of Card Stacking Pocket

The Regular Card Stacker is selected automatically is the program has not specified otherwise for the card being released. The Alternate Stacker is selected by executing the following instruction:

	OP CODE	A	B
ALTERNATE STACKING POCKET	ALTP		

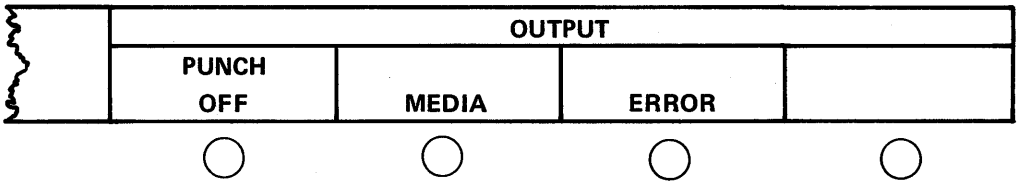
The ALTP instruction causes the card in the Punch Station to be routed to the Alternate Stacking Pocket after it has been released from both the Punch Station and the Read Station. The ALTP instruction must be executed while the card is still in the Punch Station, and prior to any instruction that will cause the card to be released from the Punch Station, in order to affect that card when it is finally released from the Read Station.

This instruction can be used to advantage in many ways, such as to segregate two groups of transactions, or to out-sort special information cards from standard transaction cards (such as low quantity alerts, etc.) or to collect reject cards from error entries.

If the punch is off-line, the ALTP instruction is executed as a NOP instruction.

OUTPUT INDICATOR LIGHTS AND FLAGS

Three of the Output Indicator Lights on the Series L keyboard are used to advise the operator of the operating status of the card punch.

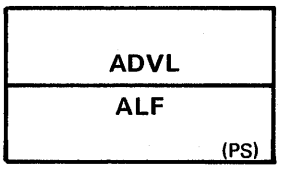


Output Indicator Lights

Punch Off Indicator

The Punch Off Indicator Light is turned on and Punch Flag P4 is set if the card punch "On-Line" switch is not on, or if the On/Off switch is not on while a card punching instruction is attempted. The punch portion of the instruction is inhibited and the instruction is executed in the manner of its counterpart keyboard or print instruction. The program does not halt. An instruction involving no other functions but punching is executed as a NOP instruction. The correction of the condition by turning on the punch and placing it in the On-Line mode will cause the indicator to be turned off and Punch Flag P4 to be reset on the next punch instruction.

To avoid the possibility of the operator failing to turn on the punch when beginning an operation, it is recommended that during the program initialization a card be released (SKP 1) and the Punch Off Flag P4 be examined. If P4 is set, the program can warn the operator (with the Alarm or by printing a warning message) and in addition may prohibit further processing or halt to allow an operator decision as to whether the following group of transactions requires card output.



Card not Present Indicator (Media)

If the program attempts to execute a punch instruction and a card is not registered in the punch station, the instruction is held up, the Media Indicator light is turned on, and Punch Flag P1 is set. Correction of the condition by registering a card in the punch station permits the instruction to be executed, at which time the Indicator light is turned off and Punch Flag P1 is reset. Only the Indicator light can be used to notify the operator that a card is not present in the punch station since the P1 flag is set only while the punching instruction is held up and is reset after the punching instruction is executed.

Error Indicator (Echo Check)

The Error Indicator Light is turned on and Punch Flag P2 is set if a card punch malfunction or misoperation occurs. If this condition occurs, the card punch is not operative, the RESET key (switch-light) on the card punch is turned on, and the program is held up on the punch instruction. A depression of the RESET key removes the error condition and permits execution of that instruction to be completed and the program to continue; Punch Flag P2 and the Indicator light are turned off.

Depression of the RESET key does not change the fact that mis-punching may have occurred, or that a newly registered card may be out of synchronization with the punch count register.

Flag Instructions (Load, Set, Reset, Change)

The execution of a LOD, SET, RST, or CHG Flag instruction involving the Punch Flags will also cause their associated indicator lights to either be turned on or off depending on the instruction used.

Program Keys

Program keys that have been enabled prior to a card punch instruction involving a keyboard entry (XTK, XTKM, XEAM) may be used to terminate that instruction. If the instruction is terminated with an OCK, such PK's as were enabled will be disabled.

ASSEMBLER PSEUDO INSTRUCTIONS

ADVANCE LINE INSTRUCTION

	OP CODE	A
ADVANCE LINE	ADVL	1-4

The ADVL pseudo instruction will advance the assembler output form the number of lines specified in the A parameter. No machine language instruction is assembled.

ALPHA CONSTANT INSTRUCTION

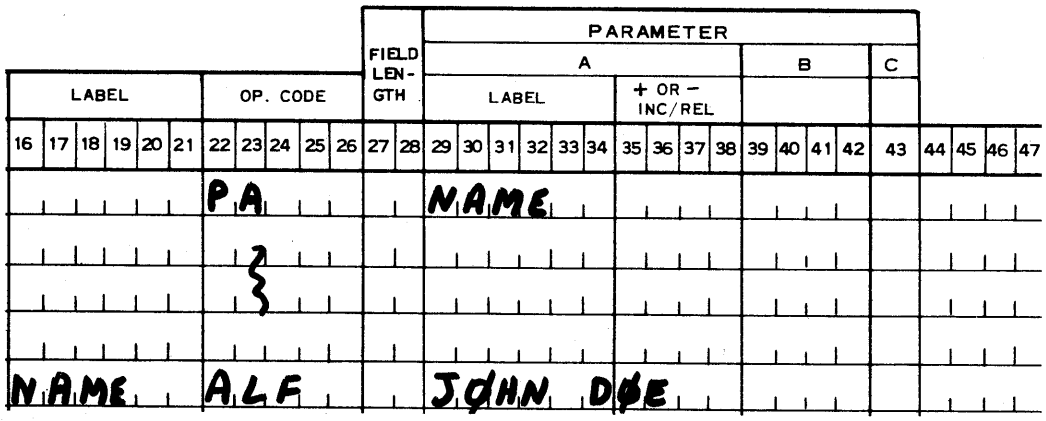
	OP CODE
ALPHANUMERIC CONSTANT	ALF

The ALF pseudo instruction permits alphanumeric data, up to 24 characters, to be stored in memory as constant data during program loading. Any character on the keyboard, including space, is a valid character. (Except for Assembler I, a CC in columns 27 and 28 will allow a second line of 24 characters to be entered.)

If the syllable counter is not 0 at the beginning of the ALF, "STOP" instructions are inserted until the counter is 0. The alphanumeric constant is then assembled starting in the next full word.

The alpha data is identified by placing a label in the label field, unless reference will be made by + or – incrementing from another entry.

Example:



LABEL	OP CODE	A
	PA	NAME
NAME	ALF	JOHN DOE

When the PA instruction is executed, the alphanumeric characters JOHN DOE would be printed (including the space).

RESERVE CARD BUFFER INSTRUCTION

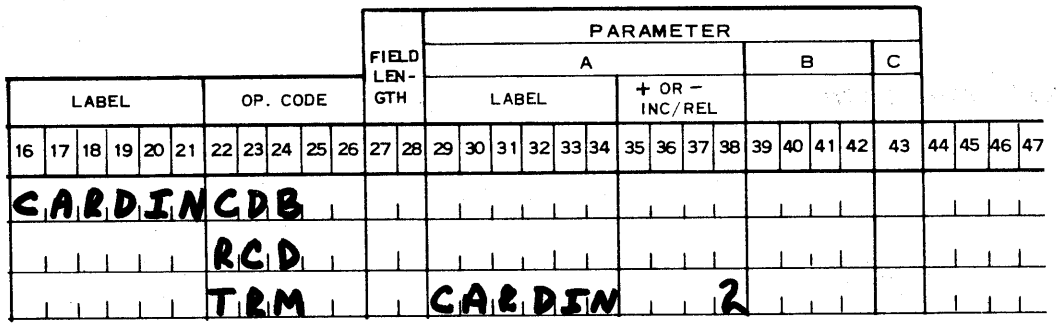
	OP CODE
RESERVE CARD BUFFER	CDB

The CDB pseudo instruction inserts the instruction "BRU to word 11, syllable 0" in word 0, syllable 0. This causes the assembler to reserve words 1-10 as the card read-in buffer area. If the assembly word counter is not at word 0, syllable 0, an error message will print. (When using Assembler I, the assembly will halt; with Assembler III or IV it will not halt, but 10 words will not be reserved.)

Accordingly, the CDB instruction must be the first instruction in the program except for pseudo instructions which do not affect memory allocation such as "Note."

When the card input data is no longer needed, the 10-word read-in area may be referenced as working memory by other parts of a program. This is accomplished by providing the CDB instruction with a label.

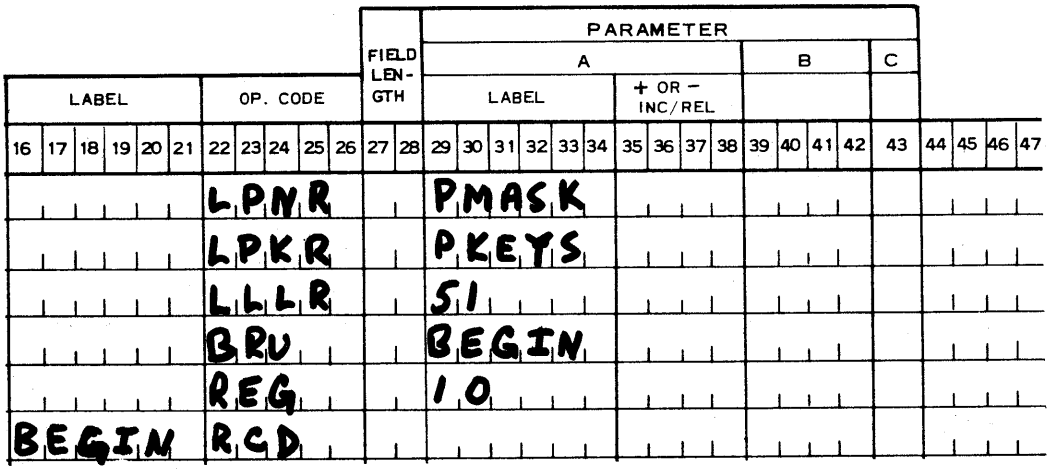
Example:



LABEL	OP CODE	A	B	REMARKS
CARDIN	CDB			Reserve Card Buffer,
	RCD			Read 1 card.
	TRM	CARDIN+2		Use 3rd word of card read buffer as a working memory location.

The card input area can be reserved by using the "REG" pseudo instruction. In this circumstance the programmer must include his own provision to by-pass the 10-word buffer area.

Example:



LABEL	OP CODE	A	B	REMARKS
	LPNR	PMASK		Assembles in word 0
	LPKR	PKEYS		Assembles in word 0
	LLLR	51		Assembles in word 0
	BRU	BEGIN		Assembles in word 0
	REG	10		Assembles in words 1-10
BEGIN	RCD			Assembles in word 11, syllable 0

CDF
CODE (PS)

CARD FORMAT INSTRUCTION

	OP CODE	A	B
CARD FORMAT	CDF	1-80	1-80

The CDF pseudo instruction is used to define each field for 80-column card input. The A parameter denotes the beginning card column of the field. The B parameter indicates the number of card columns in the field. The values entered are assembled into one syllable as part of the card format table.

The field formats defined in the table may pertain to one or several types of input cards, and may be in any sequence in relation to the card.

LABEL	OP CODE	A	B	REMARKS
	LCFR	FIELDS		Load Card Format Register
	WORD			
FIELDS	CDF	1	1	1 - type of card
	CDF	2	7	2 - Acct. No.
	CDF	9	6	3 - Product Codes
	CDF	15	36	4 - Product Description
	CDF	51	6	5 - Gross Weight
	CDF	57	8	6 - Price No. 1
	CDF	65	8	7 - Price No. 2
	CDF	73	8	8 - Cost
	CDF	9	24	9 - Name
	CDF	33	24	10 - Address
	CDF	57	24	11 - City-State

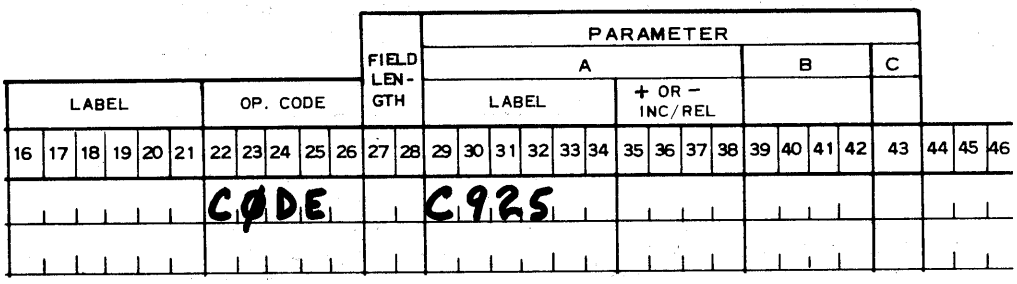
CODE INSTRUCTION

	OP CODE	A
CODE	CODE	4 hexadecimal digits

The CODE pseudo instruction permits the insertion of 4 hexadecimal digits into a syllable of a word of memory. The value designated by the 4 digits in the A parameter is inserted into the same syllable of memory. Other instructions may precede or follow its use in the same word of memory, or it may be used successively to insert a full word or several words.

DEF
DEFT
(PS)

Example:



OP CODE	A	REMARKS
CODE	C925	Print word 293 as alpha.

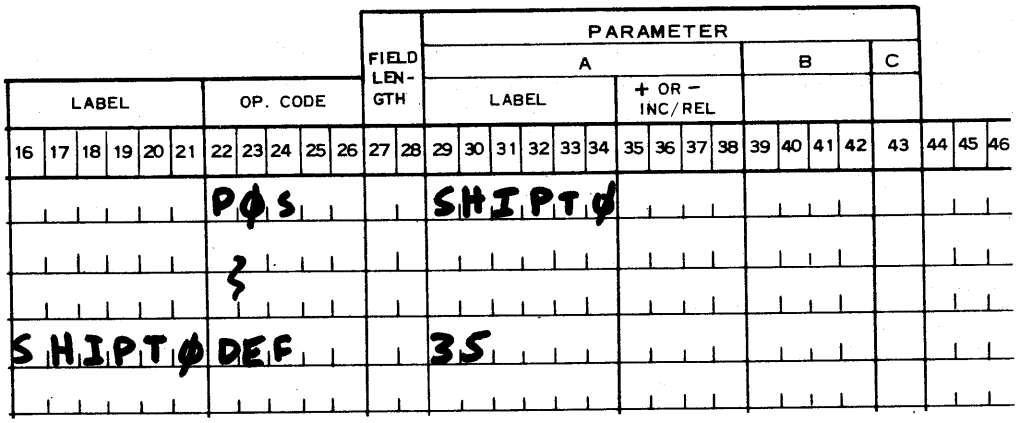
C925 is the machine language code for PA Word 293. It may sometimes be convenient to use the CODE instruction in this manner to have access to memory locations or program routines which have been loaded with another program.

DEFINE INSTRUCTIONS

OP CODE	A	B
DEF	0-256	
DEFT	0-15	0-15

The DEF pseudo instruction is used to assign a numeric value to a label. This applies to labels which name something other than a memory location.

Example:

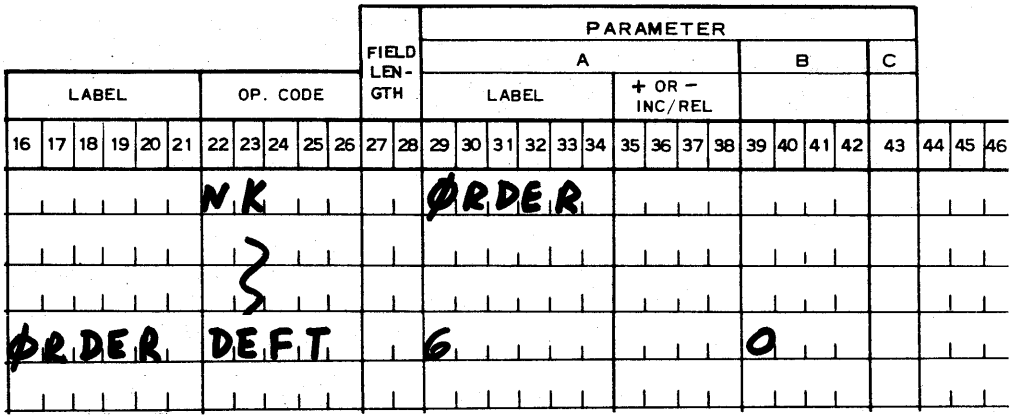


LABEL	OP CODE	A	B
	POS	SHIPTO	
	}	}	
SHIPTO	DEF	35	

The print ball positions at position 35.

The DEFT pseudo instruction is the same as the DEF instruction except that entry in both the A and B parameters is allowed. Values between 0 and 15 are permitted in each parameter.

Example:



LABEL	OP CODE	A	B
	NK	ORDER	
ORDER	DEFT	6	0

The DEF or DEFT instruction must be used in conjunction with a label (in columns 16-21) to denote the item being defined.

DOCUMENTATION INSTRUCTION (USED ONLY FOR ASSEMBLY ON B 2500/3500/5500.)

OP CODE	A	B
DOC		

The DOC pseudo instruction permits more extensive narrative to be included in programs and in the subroutine library. Remarks of up to 49 characters are entered (beginning in card column 29) which print on the assembly documentation from the B 3500, but which do not punch into the program tape (or card deck).

ESTABLISH BUFFER INSTRUCTION

OP CODE
ESTB

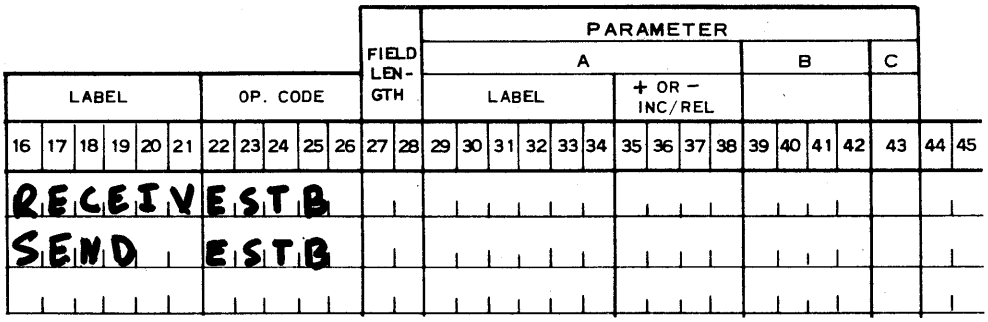
The ESTB pseudo instruction is used for reserving main memory buffer areas in connection with the data communications message handling instruction. This is required when it is desired to move a message from the Data Communications Message Received Buffer into main memory before unpacking the message, or to build a message in main memory and then transfer it (completely formatted) to the Data Communications transmit buffer.

END
EQU (PS)

The ESTB instruction reserves a 32 word area (256 characters) or 1 track in user memory. It selects the highest track of user memory that is available, reserving 32 words starting with the first word of that track.

For example, if 384 words of user memory (0 to 383) are designated in the program assembly, the first use of ESTB would reserve words 352 through 383; the second use of ESTB would reserve words 320-351. ESTB has no parameters, but it must be labeled.

Example:



LABEL	OP CODE
RECEIV	ESTB
SEND	ESTB

In the above example, RECEIV would be assembled with a word number of 352 and SEND would be assembled with a word number of 320.

END INSTRUCTION

OP CODE
END

The END pseudo instruction terminates the assembly program and must be used as the last line of code in the program.

EQUATE INSTRUCTION

OP CODE
EQU

The EQU pseudo instruction will permit one label to be given the identical value of another label. The label coded in columns 16-21 will be equated to the label in columns 29-34. The label contained in the parameter field (column 29-34) must have been previously used or defined.

MASK
NOTE (PS)

MASK INSTRUCTION

OP CODE

MASK

The MASK pseudo instruction is used to enter the table of mask words. An entry of up to 24 print format characters is accepted.

If the syllable counter is not 0 at the beginning of the Mask instruction, "Stop" instructions are inserted until the counter reaches 0. The Mask Characters are then assembled in the next full word.

The appearance of any character other than those listed in the Mask Character Table (see Appendix E) results in an error condition.

The mask table must be identified by placing its label in the label field (columns 16-21) on the line of the first mask word entry. For Assemblers other than the Assembler I, the number of mask characters must appear in the field length.

Example: See page 2-12.

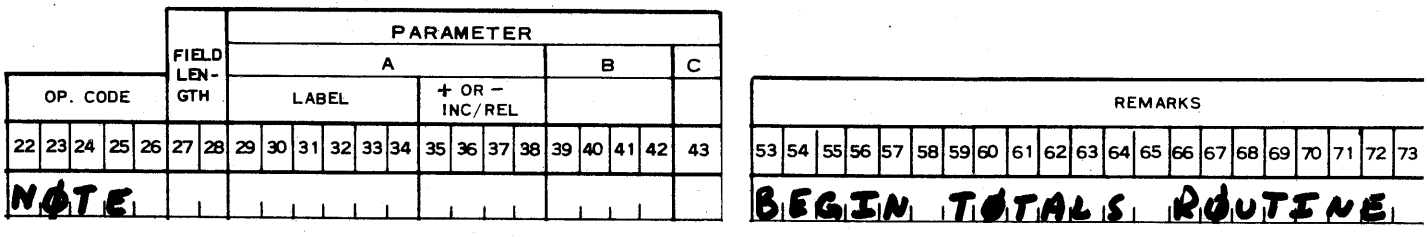
NOTE INSTRUCTION

OP CODE

NOTE

The NOTE pseudo instruction will permit the entry of up to 25 characters in the REMARKS field (columns 53-77). No machine language instruction is assembled. No parameter field entry is required. If one is given, it will be ignored.

Example:



OP CODE

NOTE

REMARKS

Begin total routine.

NUM
ORG (PS)

NUMBER INSTRUCTION

OP CODE
NUM

The NUM pseudo instruction permits a word of numeric data to be stored as constant data in memory during program loading.

A numeric constant of from 0 to 15 digits (Assembler I will allow only 14 digits) consisting of the digits 0-9 is accepted. In addition, the "–," "C" and "M" codes, preceding the digit position of the constant are accepted, once set their respective flags in the flag positions of the word.

If the syllable counter is not 0, "Stop" instructions are inserted until the counter is 0. The numeric constant is then assembled in the next full word, right justified.

The number must be identified by placing its name label in the label field (columns 16-21) of the coding form, unless reference will be made to it by +/– incrementing from another entry.

Example:

		FIELD LEN-GTH	PARAMETER			
			A		B	C
LABEL	OP. CODE		LABEL	+ OR – INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43
	MUL		PI			
PI	NUM		3141592653589793			

LABEL	OP CODE	A	B	REMARKS
	MUL	PI		Multiply by PI
PI	NUM	314159265358979		PI to 15 places.

ORIGIN INSTRUCTION

OP CODE	A
ORG	

The ORG pseudo instruction will assemble the next instruction in syllable 0 of the word specified in the parameter field. If the specified word has already been assigned by the assembler, an error message will be printed and entry assignment will start at the same sequence.

No machine language instruction is assembled.

PAGE INSTRUCTION

OP CODE	A
PAGE	

The PAGE pseudo instruction will cause the assembler output to be spaced to the top of a new form.

REGION INSTRUCTION

OP CODE	A
REG	1-255

The REG pseudo instruction sets aside the number of words of memory specified by the A parameter. The actual memory address is assigned by the assembler. If the syllable counter is not 0, "Stop" instructions are inserted until the counter equals zero.

The word counter is advanced by the amount in the A parameter field. If the word counter exceeds the highest order word available, an error message is printed and entry assignment will start at the same sequence number.

No machine language instruction is assembled. The region must be identified by placing its name label in the label field (columns 16-21) of the coding form. This region is not cleared.

Example:

		FIELD LEN-GTH	PARAMETER			
			A		B	C
LABEL	OP. CODE		LABEL	+ OR − INC/REL		
16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43 44 45 46
	LKBR		AREA			
	TKM		25			
	?					
AREA	REG		4			

LABEL	OP CODE	A	B	REMARKS
	LKBR	AREA		Load keyboard
	TKM	25		Type 25
AREA	REG	4		Save 4 words

WORD

(PS)

WORD INSTRUCTION

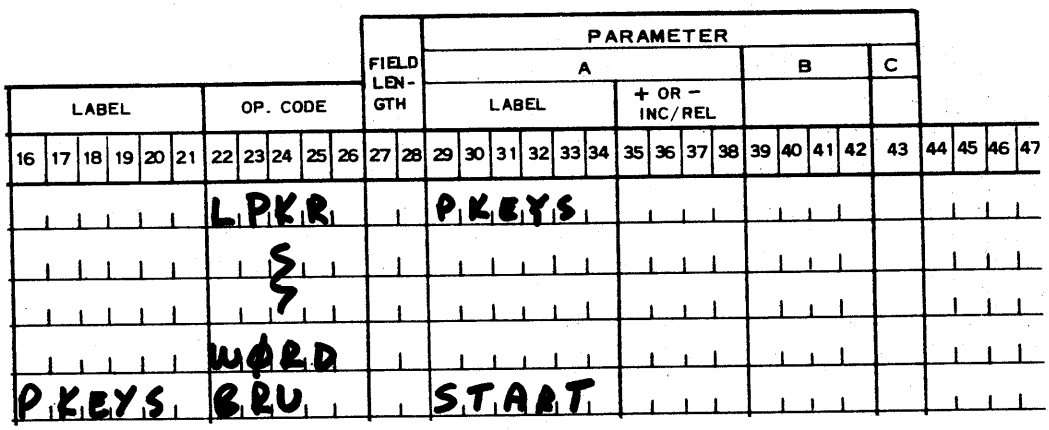
OP CODE	A
WORD	

The WORD pseudo instruction causes the assembler to assign the next instruction at the beginning syllable of the next word.

If the syllable counter is not 0, it will be incremented and "Stop" instruction inserted into each syllable until the counter reaches 0.

This instruction should immediately precede the entry of a Program Key Table.

Example:



LABEL	OP CODE	A	B	REMARKS
	LPKR	PKEYS		
	WORD			
PKEYS	BRU	SRT		

SECTION 3

SYMBOLIC PROGRAMING PROCEDURES

PROGRAM DEFINITION

A program definition is a set of specifications used for the efficient development of the application software needed for a machine-oriented data processing system. The program definition procedure is:

1. Systems Analysis.
2. Defining the output.
3. Defining the processing.
4. Defining the input.
5. Evaluating the system and,
6. Defining for programing – or – reanalyzing and repeating the procedure.

When the program definition procedure is used to design an acceptable system, the system specifications are recorded in the form of:

1. A general systems flow chart of the complete data processing system.
2. Completed Program Definition Worksheets, MKTG 2366, illustrating the required output from each program in the system.
3. Complete Program Definition Charts, MKTG 2402, explaining the input, processing, and output requirements of each program in the system.

The necessary applicational software will then be developed from this information.

PROGRAM WRITING

After the program definition specifications are completed and given to the programmer, the process of writing the program begins.

The first step the programmer should take, is to thoroughly analyze the program definition specifications. This will serve two basic purposes. First, it will enable the programmer to ask questions about any area or steps in the definition, that are unclear. This can save later reprograming on steps the programmer incorrectly understood. Second, it will give the programmer an opportunity to develop a general idea of what the program will contain when completed, how much memory it is going to take (this evaluation becomes more accurate with experience) and to look for possible use of any routines, already written, which can be used in the program.

After the definition is thoroughly analyzed and all questions answered, the writing of symbolic instruction begins.

Every program generally has three separate sections, initialize, main body, and definition section. Coding forms should be set aside for each section. This enables the programmer to add pages to any section without interrupting the order.

An explanation of each section using the programing example in Section 4 follows.

The initialize portion of a program is generally the shortest portion of a program (in terms of numbers of instructions). In its narrowest sense, this portion will be executed before an NK or TK instruction, halts the internal program execution for the first operator action. In the example Seq. No.'s 20, 30, 40 loads the base register for the PK table, the print mask table, and the line limit register for the form being used in the machine. Even though its instructions are few in number, without them the programmer could not control the program. For example program execution stops at Seq. 90, if the operator selected PKA 5 without having the LPKR instruction at Seq. No. 20, the base register for the PK Table would contain the word number for the LPKR instruction of the previous program in the machine. Therefore selecting PKA 5 would not have caused the execution of the BRU INCOST instruction.

A broader description of the initialize section would be to include routines in the program which are not part of the main program. Seq. steps 1 through 5 on the Program Definition Chart in Section 4 could be included under this broader definition. These sequence steps are not concerned with the mainline function, i.e., creating the invoice, but rather prepare the system for invoice writing.

The second section of a program, the main body, is the area of the program which accomplishes the task assigned to the program. In the programing example, sequence steps 6 through 32, are concerned with creating an invoice. Each sequence step should be completely programed before going to the next. In the example, sequence steps 8 through 14, are accomplished by Sequence Numbers 430 to 570. Since these sequence steps are concerned with the ribbon line on the invoice, the programmer has labeled Sequence No. 430 RIBBON. The use of descriptive labels gives the program added readability. This enables others who read the program documentation to follow the logic with a better understanding. Using the REMARKS field on each instruction to explain the purpose of the instruction also increases the readability of a program. These comments in the REMARKS field also help the programmer when debugging the program.

While programing the sequence steps from the Program Definition Chart, the programmer will generally make use of three techniques, straight line, loops, and subroutines. The straight line method is exactly as its name implies, it is a series of instructions, without any branches which solves the given problem. Sequence numbers 110 through 230 are an example of this method. This sequence accomplishes the task of storing the page number, positioning the printer, printing the customer name, storing it, advancing the form, etc., without the use of loops or subroutines. The looping technique uses a counter to execute the same series of instructions a desired number of times. The routine which clears 11 words of memory labeled CLRMEN uses the looping technique. An index register value is incremented each time the loop is executed, up to a maximum number of times, when this limit is reached the program branches out of the loop. The subroutine technique is like the straight line method except that in the series of instructions we branch out to execute another series of instructions and when finished with these the program returns to the instruction following where we left the series. This allows writing a routine, which is to be executed a number of times during a program, only once; and going to it any time and returning to where it branched from. An example is sequence number 560 where we leave the straight line to print the date and invoice number and when finished, return to sequence number 570.

The last section of the program, the define section, is actually written along with the initialize and main body. This area contains all PK Tables, Print Masks, storage regions, numeric constants, alpha constants, etc. An example of how this section is completed would be to look at Sequence Number 30. The LPNR instruction has in its A parameter the label MASKTB. Right after this instruction is written, the programmer codes the first MASK instruction with the label MASKTB in the definition section. This process is repeated for all storage locations, numeric constants, alpha descriptions, etc., as the program is written.

After the program is written, the last step is to assemble it and debug the program when it is loaded in the machine.

PROGRAM DEBUGGING

Generally, program debugging is completed in two steps. The first step is to correct Assembler errors, these are invalid conditions which the Assembler finds in the symbolic instructions, these errors are corrected by removing the invalid conditions in the symbolic instructions. The second step is to find the logic errors, i.e., areas of the program which are not giving the desired results.

When the Assembler detects an error in the source program, the invalid instruction is replaced by a NO-OP instruction. Thus the object program contains the correct instructions and the Assembler inserted NO-OP's. It is possible to load the object program and replace the NO-OP's with the correct machine language code for the desired instruction, through the use of the Memory Modify service routine.

Logic errors can be found by analyzing the sequence of instructions or by using one of three available Trace service routines. When a logic error is found, its proposed solution should be tested before re-assembly. This is accomplished by inserting the appropriate machine language codes for the symbolics in place of the incorrect codes. If the new solution cannot be placed within the area of the incorrect codes, a branching out of that area to an area not used by the program (usually starting at the word location following the last word of the program) placing the rest of codes and then branching back into the program at the appropriate place. If the new solution is correct, then it can be written in symbolics and inserted in the program before re-assembly. Once debugging is completed, the corrected program can be obtained, by the Punch from Memory service routine.

As mentioned before, during debugging the Trace routines will sometimes be used. In general they are useful for (1) reading the program execution sequence (especially for conditional branches), (2) to check when the flags are being set or reset, (3) to read the values of the index registers (especially when used as counters in loops), (4) to read the value in the Accumulator (to debug shift and arithmetic instructions).

DATA COMM DEBUGGING

Debugging a TC 500 on-line program can be expensive if a central processor remains on demand while the TC 500 operator is detecting and correcting errors on the TC. It is possible to debug off-line by using the memory modify utility routine, especially the selective start feature.

The first word of the receive buffer in Data Comm Memory is located in word 1245. The second word is 1216 and the remaining words follow serially to word 1246. Knowing this, it is possible to access these words using memory modify and index from the keyboard the USASCII code representation of the characters of any message the operator is anticipating, thus doing the work of data comm memory by placing the message in the receive buffer. Then, using the selective start feature of memory modify, access the word and syllable of the instruction immediately after the receive flag (R2) has been interrogated and determined to be set. The object program will begin executing from that word and syllable. This routine allows the operator to proceed as if a message had been received from the central processor and allows testing of those parts of the object program that unpack messages.

Likewise, the transmission of messages can be tested off-line. The first word of the transmit buffer is located in word 1249 and the next 30 words proceed serially to word 1279. The last word is 1248. After programmatically packing a message into the transmit buffer, the operator should depress the

program halt button after the transmit ready flag (R3) is set (evidenced by the transmit ready light being on) and then use memory modify to read these words and determine if the message was assembled in the buffer correctly.

The word locations of transmit or receive record work areas are determined by the Assembler and would be accessed accordingly.

SECTION 4

GP 300 PROGRAMING EXAMPLE

PROBLEM

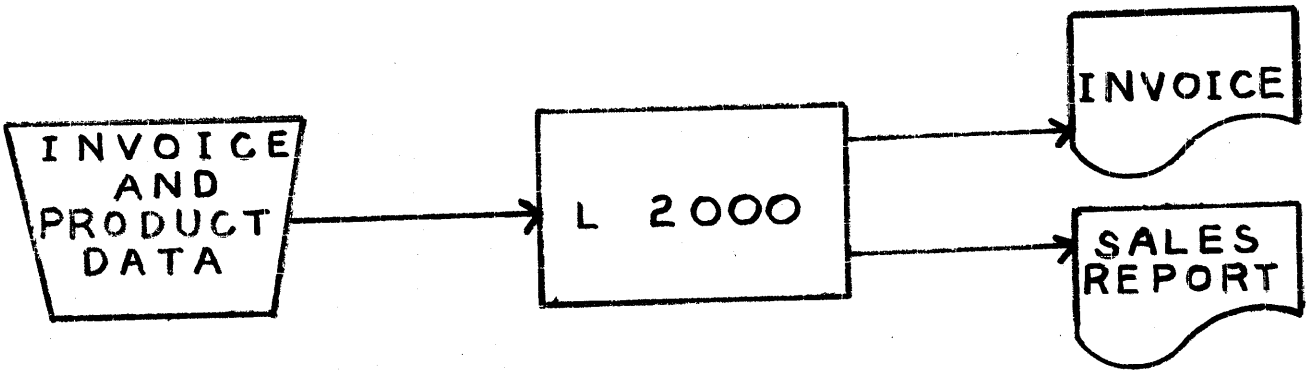
Examine the Program Definition Chart and Worksheet located on pages 4-3 through 4-6.

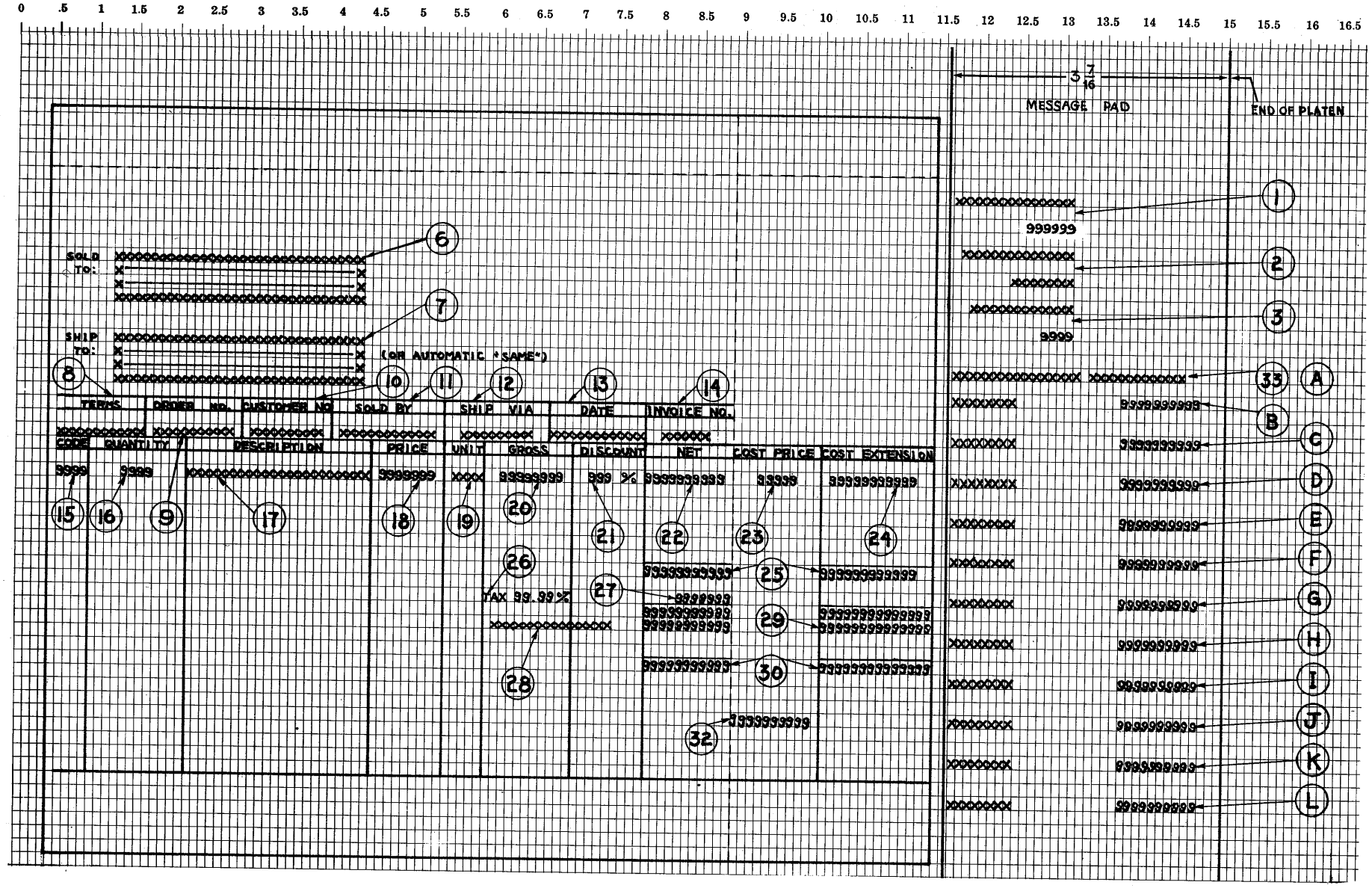
SOLUTION

The proposed solution is located from page 4-7 to page 4-32.

SOLUTION INDEX

SAMPLE BILLING PROGRAM
GENERAL SYSTEMS FLOWCHART





PROGRAM DEFINITION WORKSHEET

SEQUENCE	DATA DESCRIPTION OR OPERATION	INPUT: ALPHANUMERIC (A)	INPUT: NUMERIC (N)	INPUT: FIELD DEFINITION INPUT: Fixed Size	INPUT: FIELD DEFINITION INPUT: Variable Min	Variable Max	Variable Norm	INPUT SOURCE (Keyboard (KB), Specify Media, Specify MB, OCK, PK, etc., only if particular one required; Punched Card (PC); Edge Punched Card (EPC); Punched Tape (PT); Striped Ledger (SL), Specify Reader; Memory (M); Data Com Receive.)	PROCESSING REQUIREMENTS (Accumulations; Formulas; Extensions; Store for later use; Calculations; Formatting for output.)	OUTPUT: PRINT (✓)	OUTPUT: PUNCH (✓)	OUTPUT: FIELD DEFINITION OUTPUT: Fixed Size	OUTPUT: FIELD DEFINITION OUTPUT: Variable Min	Variable Max	Variable Norm	OUTPUT DETAIL (Print: Specify Printer and Format Console (CP),, Line Printer (LP); Punch: Specify Adjunct, Format, Special codes, etc.; Striped Ledger: Data Com Transmit.)	INSTRUCTIONS
1.	INVOICE NUMBER	N			0	6	5	KB	STORE FOR AUTOMATIC PRINT INDEX ZERO IF NOT AUTOMATIC	✓			0	6	5		
2.	DATE	A			6	12	11	KB	STORE FOR AUTOMATIC PRINT	✓			6	12	11		
3.	TAX RATE	N			0	4	2	KB	STORE FOR CALCULATION	✓			0	4	2		
4.	CLEAR DAILY TOTALS							PK SELECTION									
5.	CHOICE OF INVOICE							SELECT OCK OR PK									
	A) COST AND SELL								COMPUTE AND PRINT COST EXT.								
	B) STANDARD (SELL ONLY)								SELL EXTENSION ONLY								
6.	SOLD-TO INFORMATION	A			0	31		KB	1-4 LINES, STORE NAME (LINE 1) FOR POSSIBLE CONTINUATION PAGE	✓			0	3	1		
7.	SHIP-TO INFORMATION	A			0	31		KB	1-4 LINES OR AUTOMATIC "SAME" SELECTED BY OCK IN #6								
8.	TERMS	A			0	11	11	KB		✓			0	11	11		
9.	ORDER NUMBER	A			1	10	10	KB		✓			1	10	10		
10.	CUSTOMER NUMBER	A			1	9		KB		✓			1	9			
11.	SOLD BY	A			0	12		KB		✓			0	12			
12.	SHIP VIA	A			1	9		KB		✓			1	9			
13.	DATE							M		✓			6	12	11		
14.	INVOICE NUMBER									✓			0	6	5		
	A) IF STORED							M		✓			0	6	5		
	B) IF NOT STORED	A			0	6	5	KB									
15.	PRODUCT NUMBER	N			0	4	4	KB	MUST BE LESS THAN 5,000 (PROVIDE ERROR INDICATION)	✓			0	4	4		
16.	QUANTITY	N			0	7	3	KB	ENABLE RE KEY; OPTION OF DISCOUNT OR NO DISCOUNT BY OCK SELECTION							RED AND "-" IF MINUS	
17.	PRODUCT DESCRIPTION	A			0	23	15	KB	PERMIT MULTIPLE LINES	✓			0	23	15	23 CHARACTER MAXIMUM PER LINE	

CUSTOMER _____ APPLICATION _____

EQUIPMENT _____

SALESMAN _____ BRANCH _____ DATE _____

Printed in U. S. America

3-69

PROGRAM DEFINITION CHART

1040060

SEQUENCE	DATA DESCRIPTION OR OPERATION	INPUT: ALPHANUMERIC (A)	INPUT: NUMERIC (N)	INPUT: FIELD DEFINITION INPUT Fixed Size	INPUT: FIELD DEFINITION INPUT Variable Min	INPUT: FIELD DEFINITION INPUT Variable Max	INPUT: FIELD DEFINITION INPUT Variable Norm	INPUT: INPUT SOURCE (Keyboard (KB), Specify Media, Specify MB, OCK, PK, etc., only if particular one required; Punched Card (PC); Edge Punched Card (EPC); Punched Tape (PT); Striped Ledger (SL), Specify Reader; Memory (M); Data Com Receive.)	PROCESSING: PROCESSING REQUIREMENTS (Accumulations; Formulas; Extensions; Store for later use; Calculations; Formatting for output.)	OUTPUT: PRINT (✓)	OUTPUT: PUNCH (✓)	OUTPUT: FIELD DEFINITION OUTPUT Fixed Size	OUTPUT: FIELD DEFINITION OUTPUT Variable Min	OUTPUT: FIELD DEFINITION OUTPUT Variable Max	OUTPUT: FIELD DEFINITION OUTPUT Variable Norm	OUTPUT: OUTPUT DETAIL (Print: Specify Printer and Format Console (CP),, Line Printer (LP); Punch: Specify Adjunct, Format, Special codes, etc.; Striped Ledger: Data Com Transmit.)	INSTRUCTIONS
18	SELL PRICE	N			0	7	3	KB	ENABLE "C", "M" KEYS DISPLAY EITHER CENTS OR CENTS AND MILLS PROVIDE TEST TO SELECT MASK AND SCALE ARITHMETIC ACCORDINGLY	✓			2	7	3		
19	UNIT																	
	A) IF "C","M","EA" PRICING							M	AUTOMATIC PRINT	✓			0	2	1	"C","M" OR "EA" PRINT	
	B) OTHERWISE	A			0	4	2	KB		✓			0	4	2		
20	GROSS							M	GROSS = PRICE × QUANTITY	✓			2	8	5	RED AND "−" IF MINUS	
21	DISCOUNT (IF SELECTED AT #16)	N			1	4	1	KB	SCALE AT 99.99	✓			0	4	1		
22	NET AMOUNT							M	NET = GROSS − [DISCOUNT × GROSS]	✓						RED AND "−" IF MINUS	
23	COST PRICE (IF SELECTED AT #5)	N			0	7	3	KB	CENTS OR CENTS AND MILLS	✓			2	7	3		
24	COST AMOUNT (IF APPLICABLE)							M	COST = COST PRICE × QUANTITY	✓			2	8	5		
25	INVOICE SUBTOTAL																
	A) SELL							M		✓			2	8	5	RED AND "−" IF MINUS	
	B) COST (IF APPLIES)							M		✓			2	8	5	RED AND "−" IF MINUS	
26	TAX % (OPTIONAL)																
	A) AUTOMATIC																
	B) INDEXED	N			0	4	1	KB		✓			0	4	2		
27	TAX AMOUNT (IF APPLICABLE)							M	TAX AMOUNT = SUBTOTAL × TAX %	✓			2	8	5		
28	ADDONS (OPTIONAL) INDEFINITE NUMBER																
	A) DESCRIPTION	A			0	18	6	KB		✓			0	18	6		
	B) AMOUNT	N			0	18	6	KB		✓			0	8	4	RED AND "−" IF MINUS	
29	COST ADDON AMOUNT	N			0	5	5	KB		✓			0	5	5		

CUSTOMER APPLICATION

EQUIPMENT

SALESMAN BRANCH DATE

Printed in U. S. America

3-69

PROGRAM DEFINITION CHART

1040060

SEQUENCE	DATA DESCRIPTION OR OPERATION	INPUT: ALPHANUMERIC (A)	INPUT: NUMERIC (N)	INPUT: FIELD DEFINITION INPUT Fixed Size	INPUT: FIELD DEFINITION INPUT Variable Min	Max	Norm	INPUT SOURCE (Keyboard (KB), Specify Media, Specify MB, OCK, PK, etc., only if particular one required; Punched Card (PC); Edge Punched Card (EPC); Punched Tape (PT); Striped Ledger (SL), Specify Reader; Memory (M); Data Com Receive.)	PROCESSING REQUIREMENTS (Accumulations; Formulas; Extensions; Store for later use; Calculations; Formatting for output.)	PRINT (√)	PUNCH (√)	OUTPUT: FIELD DEFINITION OUTPUT Fixed Size	OUTPUT: FIELD DEFINITION OUTPUT Variable Min	Max	Norm	OUTPUT DETAIL (Print: Specify Printer and Format Console (CP),, Line Printer (LP); Punch: Specify Adjunct, Format, Special codes, etc.; Striped Ledger: Data Com Transmit.)	INSTRUCTIONS
30	INVOICE TOTAL																	
	A) SELL							M	TOTAL = SUBTOTAL + TAX + ADDONS									
	B) COST (IF APPLICABLE)							M	COST TOTAL = SUBTOTAL + ADDONS									
31	AUTOMATIC CONTINUATION PAGES								IF INVOICE IS BEYOND ONE PAGE. ALLOW FOR INDEFINITE NUMBER.									
	A) SOLD TO NAME				03	1		M										
	B) PAGE NUMBER							M	AUTOMATIC INCREMENT OF 1									
	C) INVOICE NUMBER																	
	i) STORED							M										
	ii) NOT STORED	A			07	5		KB										
32	PROFIT							M	PROFIT = NET − COST AMOUNT									
33	DAILY TOTALS							M	SELECT WITH PK, IDENTIFY NUMERIC FIGURES WITH ALPHA MESSAGE									
	A) HEADING																	
	B) TOTAL GROSS																	
	C) TOTAL NET SALES																	
	D) TOTAL PLUS ADDONS																	
	E) TOTAL MINUS ADDONS																	
	F) TOTAL PLUS COST ADDONS																	
	G) TOTAL MINUS COST ADDONS																	
	H) TOTAL TAXES																	
	I) TOTAL DISCOUNTS																	
	J) ACC. REC. NET																	
	K) TOTAL NET COSTS																	

CUSTOMER APPLICATION

EQUIPMENT

SALESMAN BRANCH DATE

Printed in U. S. America

PROGRAM DEFINITION CHART

1040060

BURROUGHS ASSEMBLER CODING FORM

PAGE 1 OF 26

CUSTOMER

BRANCH

PROGRAMMER

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	0 1 0 1 0		NØTE						BASIC BILLING PRØGRAM
	0 1 0 2 0		LPKR		PKTABL				LØAD PK BASE REGISTER
	0 1 0 3 0		LPNR		MASKTB				LØAD PRINT NUM. BASE REG.
	0 1 0 4 0		LLLR		51				LØAD LEFT LIMIT REGISTER
	0 1 0 5 0	INITAL	PKA	4	1258				ENABLE PKA1 LØAD DATE
	0 1 0 6 0		NØTE						INV. NØ. TAX, PKA2 PRINT
	0 1 0 7 0		NØTE						DAILY TØTALS, PKA5 CØST
	0 1 0 8 0		NØTE						INVØICE, PKA8 CLEAR TØTAL
	0 1 0 9 0		NK		0		0		XANY ØCK TØ START INVØICE
	0 1 1 0 0		SET		Y		3		SET STANDARD INVØICE FLAG
	0 1 1 1 0	BEGINVØC	SLDTØL	+	7				ADVANCE TØ LINE 10
	0 1 1 2 0		RST		Y		1		SET Y CØNT. PAGE
	0 1 1 3 0		CLA		0		2		CLEAR ACC. INSERT2
	0 1 1 4 0		TRM		PAGENØ				STØRE FØR PAGE NØ. 2
	0 1 1 5 0		PKA	1	7				BRANCH TØ INITIALIZE
	0 1 1 6 0		LKBR		CUSTNM				LØAD KEYBØARD BASE REG.
	0 1 1 7 0		PØS		NMADD-P				PØSITIØN TØ SØLD TØ
	0 1 1 8 0		TKM		31				XTYPE CUSTØMER NAME
	0 1 1 9 0		AL		1				ADVANCE LEFT ØNE LINE
	0 1 2 0 0		LLCR		SLDTØL				LØAD WITH SØLD TØ LINE

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG - 2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	02,010		LIR		4		0		BEGIN TYPING LOOP
	02,020		LIR		3		0		LOAD INDEX REGISTER 3
	02,030		RST		X		2		RESET X FLAG
	02,040	SHIPTO	POS		NMAD-P				POSITION TO PRINT
	02,050		TK		31				X TYPE INFO
	02,060		AL		1				ADVANCE LEFT ONE LINE
	02,070		IIR		4		2		TEST IF THIRD TIME
	02,080		EX		X		2	4	ENTER IF SHIPTO
	02,090		IIR		3		3		TEST FOR COMPLETION
	02,100		SK		T		I	1	TERMINATE LOOP
	02,110		BRU		SHIPTO				REPEAT
	02,120		BRU		RIBBON				JUMP TO RIBBON AREA
	02,130		SK		T		I	1	TERMINATE LOOP
	02,140		BRU		SHIPTO				REPEAT LOOP
	02,150		EX		K		34	1	BRANCH TO PRINT SAME
	02,160		BRU			+	4		EXIT LOOP
	02,170		SET		X		2		SET TO ENTER SHIPTO LOOP
	02,180		AL		2				ADVANCE TWO LINES
	02,190		BRU		SHIPTO				RETURN TO LOOP
	02,200		AL		2				ADVANCE TWO LINES

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

FORM MKTG-2296 (7/68)

PRINTED IN U.S. AMERICA

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	03 10		POS		NMAD-P				
	03 20		PA		SAME				PRINT ALPHA MESSAGE
	03 30	RIBBON	ALTO		RIBBL				ADVANCE TO RIBBON LINE
	03 40		POS		TERM-P				POSITION TO TERMS
	03 50		TK		1				XTYPE TERMS
	03 60		POS		ORDNOP				POSITION TO ORDER NO.
	03 70		TK		10				TYPE ORDER NO.
	03 80		POS		CUSNOP				POSITION TO CUSTOMER NO.
	03 90		TK		9				XTYPE CUSTOMER NUMBER
	03 100		POS		SLDBYP				POSITION TO SOLD BY
	03 110		TK		12				XTYPE SALES NAMES
	03 120		POS		SHPVIP				POSITION TO SHIP VIA
	03 130		TK		9				XTYPE SHIPVIA
	03 140		CLM		INVNET				CLEAR INVOICE NET TOTAL
	03 150		CLM		INVCST				CLEAR INVOICE COST TOTAL
	03 160		SRJ		DATE-J				PRINT DATE & INVOICE NO
	03 170		BRU			+2			BRU SKIP LINE INCREMENT
	03 180	BODYIV	SRJ		CKLINE				INCREMENT & CHECK LINE CT
	03 190		EX		Y		1	2	TEST FOR CONT. PAGE
	03 200		SRJ		SUBTOT				PRINT SUB-TOTAL

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	04010		SRJ		CONTPG				BEGIN CONTINUATION PAGE
	04020		RST		X		34		RESET DISCOUNT FLAG
	04030		NOTE						ADDON FLAG
	04040		PKA	13					ENABLE SUB-TOTAL PK
	04050		POS		PRDCDP				POSITION TO PRODUCT CODE
	04060	MAX	NK		4		0		INDEX NO. LESS THAN 5000
	04070		CPA		TEST				CHECK IF VALID
	04080		NOP						EQUAL TO, NO OPERATION
	04090		BRU			+2			INVALID CODE
	04100		BRU			+3			VALID PRINT
	04110		ALARM						INVALID DO NOT PRINT
	04120		BRU		MAX				TO INDEX NEXT CODE
	04130		EX		Y		1	3	TEST FOR A CONT. PAGE
	04140		SRJ		SUBTOT				PRINT SUBTOTAL
	04150		SRJ		CONTPG				BEGIN CONTINUATION PAGE
	04160		BRU		BODYIV	+6			BRANCH TO INDEX PROD-NO.
	04170		AL		1				ADVANCE LEFT ONE LINE
	04180		SLR0		11		0		SHIFT FOR PRINTING
	04190		PN		14		3		PRINT PRODUCT NO.
	04200		NKR		4		0		INDEX QUANTITY

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG - 2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	Q5010		EX		K		1	1	TEST FOR DISC OCK NO DISC
	Q5020		SET		X		3		SET X3 NO DISCOUNT FLAG
	Q5030		POS		QTY-P				POSITION TO QUANITY
	Q5040		PNS-		9		0		PRINT WHOLE NO. QUANTITY
	Q5050		PC-		-				PRINT - IF MINUS
	Q5060		SLRO		7		0		REPOSITION FOR EXTN
	Q5070		TRM		QTY				STORE QUANITY
	Q5080	TKDESC	POS		DESC-P				POSITION TO DESCRIPTION
	Q5090		TK		23				XTYPE DESCRIPTION
	Q5100		SK		K		1	4	TEST IF OCK USED
	Q5110		SRJ		CKLINE				INCREMENT LINE COUNT
	Q5120		SK		Y		1	2	TEST IF LAST INVOICE LINE
	Q5130		AL		1				ADVANCE LEFT ONE LINE
	Q5140		BRU		TKDESC				BRANCH TO TYPE DESC.
	Q5150	MPRICE	POS		SPRC-P				POSITION TO SELL PRICE
	Q5160		NKCM		5		2		XINDEX PRICE
	Q5170		EXE		A		CM	2	TEST IF BOTH C M USED
	Q5180		ALARM						WARN PRICE ERROR
	Q5190		BRU		MPRICE				BRANCH TO INDEX PRICE
	Q5200		SRJ		CTMILL				DETERMINE IF MILLS INDEX

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 | 7 8 9 10 | 11 12 13 14 | 15 | 16 17 18 19 | 20 21 22 23 24

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	06010		EX		A		−	1	TEST IF MINUS FLAG SET
	06020		BRU		MPRICE	+ 3			BRANCH TO INDEX PRICE
	06030		SRJ		PT-PRC				PRINT SELL PRICE
	06040		POS		PERU-P				POSITION TO PER UNIT COLN
	06050		EX		A		C	4	TEST IF C FLAG SET
	06060		PC		C				PRINT C
	06070		TRA		QTY				TRANSFER QUANITY
	06080		SLRO		O		2		SHIFT FOR PER C PRICE
	06090		TRM		QTY				STORE QUANITY
	06100		EX		A		M	4	TEST IF M KEY USED
	06110		PC		M				PRINT M
	06120		TRA		QTY				TRANSFER QUANITY
	06130		SLRO		O		3		SHIFT FOR PER M PRICE
	06140		TRM		QTY				STORE QUANITY
	06150		TRA		PRICE				TRANSFER SELL PRICE
	06160		EX		A		CM	1	TEST IF EITHER CM USED
	06170		BRU		GRSAMT				BRANCH TO GROSS AMOUNT
	06180		EX		K		4	3	TEST IF OCK4 USED
	06190		PC		E				PRINT E
	06200		PC		A				PRINT A

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 | 7 8 9 10 | 11 12 13 14 | 15 | 16 17 18 19 | 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	07010		BRU		GRSAMT				BRANCH TO GROSS AMOUNT
	07020		TIK		4				XTYPE PER UNIT CHARACTER
	07030	GRSAMT	LSR		9				LOAD SHIFT REGISTER
	07040		MULR		QTY				MULT PRICE X QUANITY
	07050		POS		GRS-P				POSITION TO GROSS AMOUNT
	07060		SRJ		PNUMRC				PRINT GROSS AMOUNT
	07070		TRM		WRKREG				STORE GROSS AMOUNT
	07080		ADM		TGROSS				ADD TO GRAND GROSS TOTAL
	07090		EX		X		3	1	TEST IF DISCOUNT APPLICABL
	07100		BRU		NETAMT				BRANCH TO NET AMOUNT
	07110		POS		DISC-P				POSITION TO DISCOUNT
	07120		NK		2		2		XINDEX DISCOUNT
	07130		EXZ		1				TEST IF ZERO INDEXED
	07140		BRU		NETAMT				BRANCH TO NET AMOUNT
	07150		PN		7		3		PRINT DISCOUNT AS 'A' %
	07160		PC		%				PRINT '%'
	07170		LSR		4				LOAD SHIFT REGISTER
	07180		MULR		WRKREG				MULT DISCOUNT X GROSS
	07190		SUM		WRKREG				SUBT DISCOUNT FROM GROSS
	07200		ADM		TDISCT				ADD TO TOTAL DISCOUNTS

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID (5 6 7 8 9 10): SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	0801	NETAMT	TRA		WRKREG				TRANSFER NET AMOUNT
	0802		POS		NET-P				POSITION TO NET AMOUNT
	0803		SRJ		PNUMRC				PRINT NET AMOUNT
	0804		ADM		INVNET				ADD LINE NET TO TOTAL NET
	0805		ADM		TNET				ADD TO TOTAL NET SALES
	0806		EX		Y		3	1	TEST IF COST APPLICABLE
	0807		BRU		BODYINV				BRANCH TO NEXT LINE
	0808		LSR		9				LOAD SHIFT REGISTER
	0809		POS		CPRC-P				POSITION TO COST PRICE
	0810	COSTINV	NK		3		2		INDEX COST PRICE
	0811		SRJ		CTMILL				DETERMINE IF MILLS INDEX
	0812		EX		A		−	1	TEST IF COST PRICE ERROR
	0813		BRU		COSTINV				BRANCH TO INDEX COST
	0814		SRJ		PT-PRC	+	1		PRINT COST PRICE
	0815		NOTE						SHIFT FOR MILLS
	0816		MULR		QTY				MULT COST X QUANITY
	0817		POS		CSTX-P				POSITION TO COST AMOUNT
	0818		SRJ		PNUMRC				PRINT COST AMOUNT
	0819		ADM		TCOSTS				ADD LINE COST TO TOT COST
	0820		ADM		INVCST				ADD TO INVOICE COST TOTAL

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PAGE 9 OF 26

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	09010		BRU		BØDYIV				BRANCH TØ NEXT LINE
	09020	INVITØT	PKA	24	6				ENABLE TAX & TØTAL PK
	09030		CLM		WRKREG				CLEAR WØRKING MEMØRY
	09040		LSR		4				LØAD SHIFT REGISTER
	09050		SRJ		SUBTØT				PRINT SUBTØTAL
	09060		PØS		ADØN-P				PØSITIØN TØ ALF TAX
	09070		SRJ		CKLINE				INCREMENT LINE CØUNT
	09080		NK		2		2		XINDEX MISC TAX PERCENT
	09090		EXZ		1				TEST IF ZERØ INDEXED
	09100		BRU		ADDØNS				BRANCH TØ ADDØNS
	09110		EX		Y		1	1	TEST FØR LAST LINE
	09120		SRJ		CØNTPG				BEGIN CØNTINUATIØN PAGE
	09130		EX		Y		4	1	TEST FØR LAST SIX LINES
	09140		SRJ		ADLNCK				INCREMENT LINE CØUNT
	09150		SET		X		4		SET X FØR ADDØNS
	09160		AL		1				ADVANCE LEFT ØNE LINE
	09170		PØS		ADØN-P				PØSITIØN TØ ALF TAX
	09180		PC		T				PRINT 'TAX:'
	09190		PC		A				
	09210		PC		X				

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	0010		PN		4		3		PRINT TAX AS A PERCENT
	0020		PC		%				PRINT :%:
	0030		POS		NET-P				POS TO NET COLUMN
	0040		MULR		INVNET				MULT TAX % X NET
	0050		SRJ		PNUMRC				PRINT TAX DOLLARS
	0060		ADM		TTAXES				ADD TO TOTAL TAX DOLLARS
	0070		ADM		INVNET				ADD TO TOT NET INVOICE
	0080		TRM		WRKREG				STORE TAX DOLLARS
	0090		SRJ		CKLINE				INCREMENT LINE COUNT
	0100		EX		Y		1	1	TEST IF LAST INVOICE LINE
	0110		SRJ		SUBTOT				PRINT SUB-TOTAL
	0120	ADDONS	PKA	16					ENABLE TOTAL INVOICE PK
	0130		POS		ADDON-P				POSITION TO ADDON ALF
	0140		SK		X		4	2	TEST IF FIRST ADDON
	0150		EX		Y		1	1	TEST IF LAST INVOICE LINE
	0160		SRJ		CONTPG				BEGIN CONTINUATION PAGE
	0170		SK		X		4	2	TEST IF FIRST ADDON
	0180		EX		Y		4	1	TEST IF BOTTOM OF INVOICE
	0190		SRJ		ADLNCK				INCREMENT LINE COUNT
	0200		SET		X		4		SET X4 INVOICE HAS ADDONS

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
	10		EX		Y		1	2	TEST IF LAST INVOICE LINE
	20		SRJ		SUBTOT				PRINT SUBTOTAL
	30		SRJ		CONTPG				BEGIN CONTINUATION PAGE
	40		AL		1				ADVANCE LEFT ONE LINE
	50		POS		ADON-P				POSITION TO ADDON ALF
	60		TK		18				XTYPE ADDON DESCP.
	70		POS		NETI-P				POSITION TO NET COLUMN
	80		NKR		7		0		XTYPE ADDON COST AMOUNT
	90		SRJ		PNUMRC				PRINT ADDON AMOUNT
	100		EX		A		-	1	TEST IF MINUS
	110		ADM		TADONM				ADD TO ADDONS MINUS
	120		SK		A		-	1	TEST IF PLUS
	130		ADM		TADONP				ADD TO ADDONS PLUSSES
	140		ADM		INVNEIT				ADD TO TOT NET INVOICE
	150		EX		Y		3	1	TEST IF STANDARD INVOICE
	160		BRU			+9			BRANCH TO CHECK LINE CT
	170		POS		CSTIX-P				POSITION TO COST COLUMN
	180		NKR		5		0		XINDEX ADDON COST AMOUNT
	190		SRJ		PNUMRC				PRINT ADDON COST AMOUNT
	200		ADM		INVCSIT				ADD TO TOT INV TOT COST

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	12010		EX		A		−	1	TEST IF MINUS
	12020		ADM		TADNCM				ADD TO COST TOTAL MINUS
	12030		SK		A		−	1	TEST IF PLUS
	12040		ADM		TADNCP				ADD TO COST TOTAL PLUS
	12050		SRJ		CKLINE				INCREMENT LINE COUNT
	12060		BRU		ADDONS				BRANCH TO NEXT ADDON
	12070	TOTALIEX			X		4	1	TEST IF ADDONS ON INVOICE
	12080		SRJ		SUBTOT				PRINT TOTALS
	12090		EX		Y		3	1	TEST IF STANDARD INVOICE
	12100		BRU		BEGINV				BRU TO NEXT INVOICE
	12110		TRA		INVNET				TRANSFER TOTAL NET INV.
	12120		SUA		WRKREG				SUBT TAX FROM NET
	12130		SUA		INVCST				SUBT COST FROM NET
	12140		POS		PRT%-P				POSITION TO PRINT PROFIT
	12150		SRJ		PNUMRC				PRINT PROFIT AMOUNT
	12160		BRU		BEGINV				BRANCH TO NEXT INVOICE
	12170	INV-NOSRJ			AR-POS				ADVANCE FORM POSITION
	12180		PA		FRSTLN				PRINT ALFA FRSTLN
	12190		AR		2				ADVANCE RIGHT TWO LINES
	12200		POS		120				POSITION FOR PRINT

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
	13010		NK		6		0		XINDEX INVOICE NO.
	13020		PN		5		0		PRINT INVOICE NUMBER
	13030		TRM		INVNO				STORE INVOICE NO
	13040		SRJ		AR-POS				ADVANCE FORM POSITION
	13050		PA		DAIT				PRINT ALFA DAIT
	13060		AR		2				ADVANCE RIGHT TWO LINES
	13070		POS		120				POSITION FOR PRINT
	13080		LKBR		DATE				LOAD DATE BASE M.A.
	13090		TKM		12				XTYPE DATE
	13100		SRJ		AR-POS				ADVANCE FORM POSITION
	13110		PA		TXRT				PRINT ALFA TXRT
	13120		POS		120				POSITION FOR PRINT
	13130		AR		2				ADVANCE RIGHT TWO LINES
	13140		NK		2		2		XINDEX TAX RATE
	13150		PN		7		3		PRINT TAX RATE
	13160		TRM		TAXCST				STORE FIRST TAX RATE
—	13170		BRU		INITAL				BRU TO INITIALIZE
	13180	DLYTOT	POS		120				POS SUMMARY HEADING
	13190		AR		5				ADVANCE RIGHT FIVE LINES
	13200		PA		HEADING				PRINT ALFA MESSAGE

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	14010		POS		141				
	14020		RR						PRINT DATE IN RED
	14030		PA		DATE				PRINT CURRENT DATE
	14040		AR		2				ADVANCE RIGHT TWO LINES
	14050		POS		120				POSITION FOR PRINT
	14060		PA		T-GROS				PRINT ALFA MESSAGE
	14070		AR		1				ADVANCE RIGHT ONE LINE
	14080		POS		136				POSITION FOR PRINT
	14090		TRA		TGROSS				TRANSFER TOTAL GROSS
	14100		SRJ		PNUMRC				PRINT TOTAL GROSS
	14110		LIR		1		0		LOAD INDEX REGISTER
	14120		LIR		2		0		LOAD INDEX REGISTER
	14130	DLYNET	IIR		2		28		TEST FOR THE 7 LOOP
	14140		EX		T		I	1	EXECUTE IF LOOP 7
	14150		BRU		FINAL				EXIT LOOP
	14160		ADIR		2		3		INCREMENT BY FOUR
	14170		AR		4				ADVANCE RIGHT FOUR LINES
	14180		POS		120				POSITION FOR PRINT
	14190		MOD		2				MODIFY BY REGISTER #2
	14200		PA		TNS	-4			PRINT ALFA MESSAGE

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U. S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	15010		MOD		1				MODIFY BY REGISTER #1
	15020		TRA		TNET				TRANSFER NET, COST AMOUNT
	15030		AR		2				ADVANCE RIGHT TWO LINES
	15040		POS		136				POSITION FOR PRINT
	15050		PNS-		9		1		SHIFT IF MINUS
	15060		PC-		-				PRINT - IF MINUS
	15070		ADTR		1		1		INCREMENT INDEX REG BY 1
	15080		BRU		DLYNET				REPEAT LOOP
	15090	FINAL	AR		4				ADVANCE RIGHT FOUR LINES
	15100		POS		120				POSITION FOR PRINT
	15110		PA		TDISC				
	15120		AR		1				ADVANCE RIGHT ONE LINE
	15130		POS		136				POSITION FOR PRINT
	15140		TRA		TDISCT				TOTAL DISCOUNTS
	15150		SRJ		PNUMRC				PRINT TOTAL DISCOUNTS
	15160		AR		2				ADVANCE RIGHT TWO LINES
	15170		POS		120				POSITION FOR PRINT
	15180		PA		ACT				ALFA MESSAGE
	15190		AR		1				ADVANCE RIGHT ONE LINE
	15200		ADA		TADONM				ADD MINUS ADDONS

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	16010		ADA		TADØNP				ADD PLUS ADDØNS
	16020		ADA		TNET				ADD PRØDUCT NET
	16030		SRJ		PNUMRIC				PRINT ACCT REC NET
	16040		AR		2				ADVANCE RIGHT TWØ LINES
	16050		PØS		120				PØSITIØN FØR PRINT
	16060		PA		TNC				PRINT ALFA MESSAGE
	16070		AR		1				ADVANCE RIGHT ØNE LINE
	16080		PØS		136				PØSITIØN FØR PRINT
	16090		TRA		TCØSTS				TRANSFER TØTAL CØSTS
	16100		ADA		TADNCP				ADD PLUS CØST ADDØNS
	16110		ADA		TADNCM				ADD MINUS CØST ADDØNS
	16120		SRJ		PNUMRIC				PRINT TØTAL NET CØSTS
	16130		AR		20				ADVANCE 20 LINES
	16140		BRU		INITIAL				BRU TØ INITIALIZE
	16150	AR-PØS	AR		2				ADVANCE RIGHT TWØ LINES
	16160		PØS		SM-HDP				PØS PRINT
	16170		SRR		1				SUBRØUTINE RETURN
	16180	PNUMRIC	PNS-		9		1		PRINT MØNTERY VALUE
	16190		PC-		-				PRINT - IF MINUS
	16200		SRR		1				SUBRØUTINE RETURN

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 | 7 8 9 10 | 11 12 13 14 | 15 | 16 17 18 19 | 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U. S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PAGE 17 OF 26

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LEN-GTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	17010	PT-PRC	PØS		SPRC-P				PØSITIØN TØ SELL PRICE
	17020		SK		A		S	2	TEST PRICE FØR MILLS
	17030		PN		7		1		PRINT WITH CENTS MASK
	17040		SLRØ		2		0		SHIFT LEFT TWØ PØSITIØNS
	17050		EX		A		S	1	TEST PRICE FØR MILLS
	17060		PN		7		2		PRINT WITH MILLS MASK
	17070		TRM		PRICE				TRANSFER SELL PRICE
	17080		SRR		1				SUBRØUTINE RETURN
	17090	CØNTPG	TRM		WRKREG	+ 1			TEMPØRARY STØRE AMØUNT
	17100		ØC		SLDTØL	+ 7			ADVANCE TØ CUSTØMER NAME
	17110		TK		0				CHANGE INVØICE
	17120		PØS		NMAD-P				PØSITIØN TØ PRINT
	17130		PA		CUSTNM				PRINT CUSTØMER NAME
	17140		LLCR		SLDTØL				LØAD SØLD TØ LINE NØ.
	17150		ALTØ		SHPTØL				ADVANCE TØ SHIP TØ LINE
	17160		PØS		CNTP-P				PØSITIØN TØ PRINT
	17170		PC		P				PRINT 'PAGE'
	17180		PC		A				
	17190		PC		G				
	17200		PC		E				

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PAGE 18 OF 26

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
	1&01C		TRA		PAGENØ				TRANSFER PAGE NUMBER
	1&02C		PN		2		0		PRINT PAGE NØ.
	1&03C		ADK		0		1		ADD 1 TØ PAGE NØ.
	1&04C		TRM		PAGENØ				STØRE PAGE NØ.
	1&05C		TRA		INVNØ				TRANSFER INVØICE NØ.
	1&06C		SKZ		2				TEST IF ZERØ
	1&07C		SUK		0		1		SUB 1 FRØM INVØICE NØ.
	1&08C		TRM		INVNØ				STØRE INVØICE NØ.
	1&09C		ALTØ		RIBBL				ADVANCE TØ RIBBØN LINE
	1&10C		SRJ		DATE-J				PRINT DATE & INVØICE NØ
	1&11C		TRA		WRKREG	+ 1			TRANSFER STØRED AMØUNT
	1&12C		SRR		1				SUBRØUTINE RETURN
	1&13C	SUBTØT	TRM		WRKREG	+ 1			TEMPØRARILY STØRE AMØUNT
	1&14C		PØS		NET-P	+ 3			PØSITIØN FØR UNDERSCØRE
	1&15C		PA		UNDERS				PRINT UNDERSCØRE
	1&16C		SK		Y		3	2	TEST FØR INVØICE CØSTING
	1&17C		PØS		CSTX-P	3			PØSITIØN FØR UNDERSCØRE
	1&18C		PA		UNDERS				PRINT UNDERSCØRE
	1&19C		AL		1				ADVANCE LEFT ØNE LINE
	1&20C		PØS		NET-P				PØSITIØN TØ NET AMØUNT

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
	19010		TRA		INVNET				TRANSFER TOTAL NET AMOUNT
	19020		SRJ		PNUMRC				PRINT TOTAL NET AMOUNT
	19030		SK		Y		3	3	TEST FOR INVOICE COSTING
	19040		POS		CSTX-P				POSITION TO COST AMOUNT
	19050		TRA		INVCST				TRANSFER TOT. COST AMOUNT
	19060		SRJ		PNUMRC				PRINT TOTAL COST AMOUNT
	19070		TRA		WRKREG	+ 1			TRANSFER STORED AMOUNT
	19080		SRR		1				SUBROUTINE RETURN
	19090	ADLNCK	ADIR		4		2		ADD 2 TO LINE COUNT
	19100		EX		T		I	2	TEST FOR LAST LINE
	19110		SRJ		CONTPG				PRINT TOTAL & CONT. PAGE
	19120		SRR		1				SUBROUTINE RETURN
	19130		DIR		4		232		SBT 1 FROM LINE COUNT
	19140		SRR		1				SUBROUTINE RETURN
	19150	CLRMEM	LIR		3		0		LOAD FOR COUNTER
	19160		MOD		3				MODIFY WITH COUNTER
	19170		CLM		INVNET				CLEAR MEMORY LOCATION
	19180		IIR		3		10		CONTROL NUMBER OF LOOPS
	19190		EX		T		I	4	TEST IF LAST TOTAL
	19200		CLA		0		0		CLEAR ACCUMULATOR

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	20010		SRJ		AR-POS				ADVANCE FORM POSITION
	20020		PN		1		1		PRINT ZERO
	20030		BRU		INITIAL				BRU TO INITIALIZE
	20040		BRU		CLRMEM+1				BRU TO CLEAR NEXT TOTAL
	20050	DATE-J	POS		DATE-P				POSITION TO DATE
	20060		PA		DATE				PRINT CURRENT DATE
	20070		POS		INVNOP				POSITION TO INVOICE NO.
	20080		TRA		INVNO				TRANSFER INVOICE NO.
	20090		SKZ		3				TEST FOR ZERO
	20100		PN		5		0		PRINT INVOICE NUMBER
	20110		ADK		0		1		ADD 1 TO INVOICE NO.
	20120		TRM		INVNO				STORE INVOICE NO
	20130		EXZ		1				TEST FOR ZERO
	20140		TK		7				XTYPE INVOICE NO.
	20150		LIR		4		234		LOAD FOR LINE COUNT
	20160		RST		Y		41		RESET Y 4 AND 1
	20170		ALTØ		BODYL				ADVANCE TO INVOICE BODY
	20180		SRR		1				SUBROUTINE RETURN
	20190	CKLINE	SK		Y		4	4	TEST IF LAST SIX LINES
	20200		IIR		4		248		INCREMENT FOR LINE COUNT

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

FORM MKTG-2296 (7/68)

PRINTED IN U.S. AMERICA

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
	2010		SK		T		I	1	TEST FOR 17TH LINE
	2020		SRR		1				SUBROUTINE RETURN
	2030		NOTE						SET Y FOR LAST 6 LINES IN
	2040		SET		Y		4		BODY OF INVOICE REACHED
	2050		IIR		4		255		INCREMENT LINE COUNT
	2060		ALARM						WARN OPERATOR BOTTOM INV.
	2070		EX		T		I	1	TEST FOR LAST LINE
	2080		SET		Y		1		SET Y1 FOR CONT. PAGE
	2090		SRR		1				SUBROUTINE RETURN
	2100	CTMILL	TRM		WRKREG				TRANSFER PRICE TO M.A.
	2110		SLRO		13		0		SHIFT OFF DOLLARS & CENTS
	2120		EXZ		3				TEST IF ZERO MILLS
	2130		TRA		WRKREG				TRANSFER PRICE
	2140		SLRO		0		2		REPOSITION FOR CENTS ONLY
	2150		SRR		1				SUBROUTINE RETURN
	2160		TRA		WRKREG				TRANSFER PRICE
	2170		SLRO		0		7		SHIFT OFF 7 DIGITS
	2180		NOTE						TEST IF MORE THAN SEVEN
	2190		SKZ		3				DIGITS WERE INDEXED
	2200		SET		A		-		YES, SET - FLAG

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U.S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID					
5	6	7	8	9	10
S	A	M	P	L	E

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	22010		ALARM						WARN OPERATOR ERROR PRICE
	22020		SIRI		I				SUBROUTINE RETURN
	22030		TRA		WRKREG				TRANSFER PRICE
	22040		NOTE						SET FLAG TO INDICATE
	22050		SET		A		S		CENTS AND MILLS
	22060		SRR		I				SUBROUTINE RETURN
	22070	IVCOST	RST		Y		3		RESET STANDARD INV. FLAG
	22080		BRU		BEGINV				BRU TO INVOICE ROUTINE
	22090		WORD						PROGRAM KEY TABLE
	22100	PKTABL	BRU		INV-NO				BRU LOAD DATE INV NO TAX
	22110		BRU		DLYTOT				BRU TO PRINT DAILY TOTALS
	22120		BRU		INVTOT				BRU TO SUBTOTAL
	22130		TRA		TAXCST				TRANSFER TAX PERCENT
	22140		BRU		IVCOST				BRU TO COST INVOICE
	22150		BRU		TOTALI				BRU TO TOTAL INVOICE
	22160		BRU		INITIAL				BRU TO INITIALIZE
	22170		BRU		CLRMEM				BRU TO CLEAR MEMORY
	22180		PAGE						
	22190	MASKTB	MASK	15	ZZZ,ZZZ,ZZZ,ZZZ				NUMERIC
	22200		MASK	16	Z,ZZZ,ZZZ,ZZZ.DD				MONETARY ZERO PRINT

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

FORM MKTG-2296 (7/68)

PRINTED IN U.S. AMERICA

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
	23010		MASK	15	ZZ,ZZZ,ZZZ.CCC			C	MONETARY WITH MILLS
	23020		MASK	16	ZZZZZE.ZZZZZ		ZZZ.	X	S HUNDREDS PERCENT & NO.
	23030	WRKREG	REG		2				GENERAL WORK REGISTER
	23040	INVNO	REG		1				INVOICE NUMBER
	23050	PAGENO	REG		1				PAGE NUMBER
	23060	DATE	REG		2				CURRENT DATE
	23070	CUSTNM	REG		4				CUSTOMER NAME
	23080	TAXCST	REG		1				TAX CONSTANT
	23090	QTY	REG		1				INVOICE QUANITY
	23100	PRICE	REG		1				INVOICE PRICE
	23110	INVNET	REG		1				INVOICE NET TOTAL
	23120	INVCST	REG		1				INVOICE COST TOTAL
	23130	TNET	REG		1				TOTAL NET SALES
	23140	TADONP	REG		1				TOTAL PLUS ADDONS
	23150	TADONM	REG		1				TOTAL MINUS ADDONS
	23160	TADNCP	REG		1				TOTAL PLUS COST ADDONS
	23170	TADNCM	REG		1				TOTAL MINUS ADDONS
	23180	TTAXES	REG		1				TOTAL TAXES
	23190	TCOSTS	REG		1				TOTAL COSTS
	23200	TGROSS	REG		1				TOTAL GROSS SALES

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG-2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

PAGE 24 OF 26

CUSTOMER

BRANCH

PROGRAMMER

PROGRAM ID (5–10): SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER	REMARKS
	24010	TDISCT	REG		1	TØTAL DISCØUNTS
	24020	TEST	NUM	4	5000	TEST VALUE 5000
	24030	SAME	ALF	4	SAME	
	24040	UNDERS	ALF	11	-----------	UNDERSCØRE
	24050	HEADNG	ALF	24	DAILY TØTALS FØR.....	
	24060	ACT	ALF	12	ACC REC NET	
	24070	TNC	ALF	16	TØTAL NET CØST	
	24080	TNS	ALF	24	TØTAL NET SALES	
	24090		ALF	24	TØTAL PLUS ADDØNS	
	24100		ALF	24	TØTAL MINUS ADDØNS	
	24110		ALF	24	TØTAL PLUS CØST ADDØNS	
	24120		ALF	24	TØTAL MINUS CØST ADDØNS	
	24130		ALF	24	TØTAL TAXES	
	24140		ALF	24	TØTAL CØSTS	
	24150	T-GRØS	ALF	14	TØTAL GRØSS	
	24160	TDISC	ALF	24	TØTAL DISCØUNTS	
	24170	FRSTIN	ALF	24	STARTING INVØICE NØ.	
	24180	TXRT	ALF	24	TAX RATE	
	24190	DAIT	ALF	24	CURRENT DATE	
	24200	SLDTØL	DEF		8	SØLD TØ LINE

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

BURROUGHS ASSEMBLER CODING FORM

PROGRAM ID: SAMPLE

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR − INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	25010	SHPTØL	DEF		13				SHIP TØ LINE
	25020	RIBBL	DEF		20				RIBBØN LINE
	25030	BØDYL	DEF		22				BØDY ØF INVØICE LINE
	25040	NMAD-P	DEF		13				PØS. NAME ADDRESS
	25050	TERM-P	DEF		6				PØS TERMS
	25060	ØRDNØP	DEF		19				PØS ØRDER NUMBER
	25070	CUSNØP	DEF		31				PØS CUSTØMER NUMBER
	25080	SLDBYP	DEF		42				PØS SØLD BY NAME
	25090	SHPVIP	DEF		56				PØS SHIP VIA
	25100	DATE-P	DEF		66				PØS DATE
	25110	INVNØP	DEF		80				PØS INVØICE NUMBER
	25120	PRDCDP	DEF		5				PØS PRØDUCT NUMBER
	25130	QTY-P	DEF		7				PØS QUANITY
	25140	DESC-P	DEF		22				PØS DESCRIPTIØN
	25150	SPRC-P	DEF		43				PØS SELL PRICE
	25160	PERU-P	DEF		55				PØS PER UNIT CØLUMN
	25170	GRS-P	DEF		56				PØS GRØSS AMOUNT
	25180	DISC-P	DEF		68				PØS DISCØUNT PERCENT
	25190	NET-P	DEF		76				PØS NET AMØUNT
	25200	CPRC-P	DEF		90				PØS CØST PRICE

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

PRINTED IN U S. AMERICA

FORM MKTG - 2296 (7/68)

BURROUGHS ASSEMBLER CODING FORM

CUSTOMER _____

BRANCH _____

PROGRAMMER _____

PROGRAM ID: SAMPLE

CODE	SEQUENCE	LABEL	OP. CODE	FIELD LENGTH	PARAMETER A LABEL	PARAMETER A + OR - INC/REL	PARAMETER B	PARAMETER C	REMARKS
1	11 12 13 14 15	16 17 18 19 20 21	22 23 24 25 26	27 28	29 30 31 32 33 34	35 36 37 38	39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
	2,6,0,1,0	CSTX-P	DEF		98				POS COST AMOUNT
	2,6,0,2,0	ADON-P	DEF		59				POS ALPHA ADDONS
	2,6,0,3,0	PRT%-P	DEF		87				POS PROFIT/LOSS %
	2,6,0,4,0	CNTP-P	DEF		64				POS TO CONT. PAGE
	2,6,0,5,0	SM-HDP	DEF		120				POS MISC ENTRIES RGHT
	2,6,0,6,0	SM-CTP	DEF		136				POS SUMMARY COST
	2,6,0,7,0		NOTE						X3 NO DISCOUNT LINE
	2,6,0,8,0		NOTE						X4 ADDONS ON INVOICE
	2,6,0,9,0		NOTE						Y1 START CONT. PAGE
	2,6,1,0,0		NOTE						Y3 STANDARD INVOICE
	2,6,1,1,0		NOTE						Y4 LAST 6 INVOICE LINES
	2,6,1,2,0		NOTE						X INDICATES MANUAL INDEX
	2,6,1,3,0		END						END OF JOB
	1,4								
	1,5								
	1,6								
	1,7								
	1,8								
	1,9								
	2,0								

CONSTANT DATA (NUMERIC)

ALPHANUMERIC DATA OR PRINT MASK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

FORM MKTG - 2296 (7/68)

PRINTED IN U S. AMERICA

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 001

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
MEMORY SIZE NOT ENTERED (512 ASSUMED)												
		1 0		NOTE								BASIC BILLING PROGRAM
0 0	FC69	2 0		LPKR		PKTABL				105		LOAD PK BASE REGISTER
1	F868	3 0		LPNR		MASKTB				107		LOAD PRINT NUM. BASE REG.
2	E433	4 0		LLLR		51						LOAD LEFT LIMIT REGISTER
3	F693	5 0	INITAL	PKA	4	1258						ENABLE PKA 1 LOAD DATE
		6 0		NOTE								INV. NO. TAX. PKA2 PRINT
		7 0		NOTE								DAILY TOTALS. PKA5 COST
		8 0		NOTE								INVOICE. PKA8 CLEAR TOTL
1 0	A600	9 0		NK		0		0				XANY OCK TO START INVOICE
1	6758	10 0		SET		Y		3				SET STANDARD INVOICE FLAG
2	E80F	11 0	BEGINV	OC		SLDTOL + 7				15		ADVANCE TO LINE 10
3	6552	12 0		RST		Y		1				SET Y 1 CONT. PAGE
2 0	8F02	13 0		CLA		0		2				CLEAR ACC. INSERT 2
1	3072	14 0		TRM		PAGENO				114		STORE FOR PAGE NO. 2
2	F640	15 0		PKA	1	7						BRANCH TO INITIALIZE
3	F075	16 0		LKBR		CUSTNM				117		LOAD KEYBOARD BASE REG.
3 0	E80C	17 0		POS		NMAD-P				13		POSITION TO SOLD TO
1	AD1F	18 0		TKM		31						XTYPE CUSTOMER NAME
2	ED01	19 0		AL		1						ADVANCE LEFT ONE LINE
3	E008	20 0		LLCR		SLDTOL				8		LOAD WITH SOLD TO LINE
4 0	5000	21 0		LIR		4		0				BEGIN TYPING LOOP
1	5300	22 0		LIR		3		0				LOAD INDEX REGISTER 3

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 002

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
	2	6544	23 0		RST		X		2				RESET X FLAG
	3	EB0C	24 0	SHIPTO	POS		NMAD-P				13		POSITION TO PRINT
5	0	AC1F	25 0		TK		31						XTYPE INFO
	1	ED01	26 0		AL		1						ADVANCE LEFT ONE LINE
	2	5802	27 0		TIR		4		2				TEST IF THIRD TIME
	3	4444	28 0		EX		X		2	4			ENTER IF SHIPTO
6	0	5B03	29 0		IIR		3		3				TEST FOR COMPLETION
	1	4184	30 0		SK		T		T	1			TERMINATE LOOP
	2	7C04	31 0		BRU		SHIPTO				4	3	REPEAT
	3	7809	32 0		BRU		RIBBON				9	2	JUMP TO RIBBON AREA
7	0	4184	33 0		SK		T		T	1			TERMINATE LOOP
	1	7C04	34 0		BRU		SHIPTO				4	3	REPEAT LOOP
	2	4599	35 0		EX		K		34	1			BRANCH TO PRINT SAME
	3	7C08	36 0		BRU			+ 4			8	3	EXIT LOOP
8	0	6744	37 0		SET		X		2				SET TO ENTER SHIPTO LOOP
	1	ED02	38 0		AL		2						ADVANCE TWO LINES
	2	7C04	39 0		BRU		SHIPTO				4	3	RETURN TO LOOP
	3	ED02	40 0		AL		2						ADVANCE TWO LINES
9	0	EB0C	41 0		POS		NMAD-P				13		
	1	C888	42 0		PA		SAME				136		PRINT ALPHA MESSAGE
	2	E914	43 0	RIBBON	ALTO		RIBBL				20		ADVANCE TO RIBBON LINE
	3	EB05	44 0		POS		TERM-P				6		POSITION TO TERMS

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
10 0	AC0B	45 0		TK		11						XTYPE TERMS
1	EB12	46 0		POS		ORDNOP				19		POSITION TO ORDER NO.
2	AC0A	47 0		TK		10						TYPE ORDER NO.
3	EB1E	48 0		POS		CUSNOP				31		POSITION TO CUSTOMER NO.
11 0	AC09	49 0		TK		9						XTYPE CUSTOMER NUMBER
1	EB29	50 0		POS		SLDBYP				42		POSITION TO SOLD BY
2	AC0C	51 0		TK		12						XTYPE SALES NAMES
3	EB37	52 0		POS		SHPVIP				56		POSITION TO SHIP VIA
12 0	AC09	53 0		TK		9						XTYPE SHIPVIA
1	D87C	54 0		CLM		INVNET				124		CLEAR INVOICE NET TOTAL
2	D87D	55 0		CLM		INVCST				125		CLEAR INVOICE COST TOTAL
3	285E	56 0		SRJ		DATE-J				94	2	PRINT DATE & INVOICE NO
13 0	780D	57 0		BRU			+ 2			13	2	BRU SKIP LINE INCREMENT
1	2062	58 0	BODYTV	SRJ		CKLINE				98	0	INCREMENT & CHECK LINE CT
2	4652	59 0		EX		Y		1	2			TEST FOR CONT. PAGE
3	2856	60 0		SRJ		SUBTOT				86	2	PRINT SUB-TOTAL
14 0	2850	61 0		SRJ		CONTPG				80	2	BEGIN CONTINUATION PAGE
1	6549	62 0		RST		X		34				RESET DISCOUNT FLAG
		63 0		NOTE								ADDON FLAG
2	F604	64 0		PKA	1	3						ENABLE SUB-TOTAL PK
3	EB04	65 0		POS		PRDCDP				5		POSITION TO PRODUCT CODE
15 0	A640	66 0	MAX	NK		4		0				INDEX NO. LESS THAN 5000

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 004

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
1	DA87	67 0		CPA		TEST				135		CHECK IF VALID
2	0800	68 0		NOP								EQUAL TO, NO OPERATION
3	7410	69 0		BRU			+ 2			16	1	INVALID CODE
16 0	7C10	70 0		BRU			+ 3			16	3	VALID PRINT
1	0980	71 0		ALARM								INVALID DO NOT PRINT
2	700F	72 0		BRU		MAX				15	0	TO INDEX NEXT CODE
3	4752	73 0		EX		Y		1	3			TEST FOR A CONT. PAGE
17 0	2856	74 0		SRJ		SUBTOT				86	2	PRINT SUBTOTAL
1	2850	75 0		SRJ		CONTPG				80	2	BEGIN CONTINUATION PAGE
2	7C0E	76 0		BRU		BODYIV	+ 6			14	3	BRANCH TO INDEX PROD-NO.
3	E001	77 0		AL		1						ADVANCE LEFT ONE LINE
18 0	02B0	78 0		SLRO		11		0				SHIFT FOR PRINTING
1	D4E3	79 0		PN		14		3				PRINT PRODUCT NO.
2	A440	80 0		NKR		4		0				INDEX QUANTITY
3	4592	81 0		EX		K		1	1			TST FOR DISC OCK1 NO DISC
19 0	6748	82 0		SET		X		3				SET X3 NO DISCOUNT FLAG
1	EB06	83 0		POS		QTY-P				7		POSITION TO QUANITY
2	D190	84 0		PNS-		9		0				PRINT WHOLE NO. QUANTITY
3	C52D	85 0		PC-		-						PRINT - IF MINUS
20 0	0270	86 0		SLRO		7		0				REPOSITION FOR EXTN
1	307A	87 0		TRM		QTY				122		STORE QUANITY
2	EB15	88 0	TKDESC	POS		DESC-P				22		POSITION TO DESCRIPTION

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
	3	AC17	89 0		TK		23						XTYPE DESCRIPTION
21	0	4092	90 0		SK		K		1	4			TEST IF OCK1 USED
	1	2062	91 0		SRJ		CKLINE				98	0	INCREMENT LINE COUNT
	2	4252	92 0		SK		Y		1	2			TEST IF LAST INVOICE LINE
	3	ED01	93 0		AL		1						ADVANCE LEFT ONE LINE
22	0	7814	94 0		BRU		TKDESC				20	2	BRANCH TO TYPE DESC.
	1	EB2A	95 0	MPRICE	POS		SPRC-P				43		POSITION TO SELL PRICE
	2	A252	96 0		NKCM		5		2				XINDEX PRICE
	3	4ECC	97 0		EXE		A		CM	2			TEST IF BOTH C M USED
23	0	0980	98 0		ALARM								WARN PRICE ERROR
	1	7416	99 0		BRU		MPRICE				22	1	BRANCH TO INDEX PRICE
	2	2864	100 0		SRJ		CTMILL				100	2	DETERMINE IF MILLS INDEX
	3	45C1	101 0		EX		A		-	1			TEST IF MINUS FLAG SET
24	0	7017	102 0		BRU		MPRICE + 3				23	0	BRANCH TO INDEX PRICE
	1	284E	103 0		SRJ		PT-PRC				78	2	PRINT SELL PRICE
	2	EB36	104 0		POS		PERU-P				55		POSITION TO PER UNIT COLN
	3	44C4	105 0		EX		A		C	4			TEST IF C FLAG SET
25	0	C043	106 0		PC		C						PRINT C
	1	387A	107 0		TRA		QTY				122		TRANSFER QUANITY
	2	0202	108 0		SLRO		0		2				SHIFT FOR PER C PRICE
	3	307A	109 0		TRM		QTY				122		STORE QUANITY

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 006

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
26 0	44C8	110 0		EX		A	M	4			TEST IF M KEY USED
1	C04D	111 0		PC		M					PRINT M
2	387A	112 0		TRA		QTY			122		TRANSFER QUANITY
3	0203	113 0		SLRD		0	3				SHIFT FOR PER M PRICE
27 0	307A	114 0		TRM		QTY			122		STORE QUANITY
1	387B	115 0		TRA		PRICE			123		TRANSFER SELL PRICE
2	45CC	116 0		EX		A	CM	1			TEST IF EITHER C M USED
3	741D	117 0		BRU		GRSAMT			29	1	BRANCH TO GROSS AMOUNT
28 0	4791	118 0		EX		K	4	3			TEST IF OCK4 USED
1	C045	119 0		PC		E					PRINT E
2	C041	120 0		PC		A					PRINT A
3	741D	121 0		BRU		GRSAMT			29	1	BRANCH TO GROSS AMOUNT
29 0	AC04	122 0		TK		4					XTYPE PER UNIT CHARACTER
1	6429	123 0	GRSAMT	LSR		9					LOAD SHIFT REGISTER
2	8C7A	124 0		MULR		QTY			122		MULT PRICE X QUANITY
3	EB37	125 0		POS		GRS-P			56		POSITION TO GROSS AMOUNT
30 0	2C4D	126 0		SRJ		PNUMRC			77	3	PRINT GROSS AMOUNT
1	306F	127 0		TRM		WRKREG			111		STORE GROSS AMOUNT
2	8085	128 0		ADM		TGROSS			133		ADD TO GRAND GROSS TOTAL
3	4548	129 0		EX		X	3	1			TEST IF DISCOUNT APPICABL
31 0	7C21	130 0		BRU		NETAMT			33	3	BRANCH TO NET AMOUNT
1	EB43	131 0		POS		DISC-P			68		POSITION TO DISCOUNT

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
2	A622	132 0		NK		2		2				XINDEX DISCOUNT
3	4500	133 0		EXZ		1						TEST IF ZERO INDEXED
32 0	7C21	134 0		BRU		NETAMT				33	3	BRANCH TO NET AMOUNT
1	D473	135 0		PN		7		3				PRINT DISCOUNT AS :A: %
2	C025	136 0		PC		%						PRINT "%"
3	6424	137 0		LSR		4						LOAD SHIFT REGISTER
33 0	8C6F	138 0		MULR		WRKREG				111		MULT DISCOUNT X GROSS
1	906F	139 0		SUM		WRKREG				111		SUBT DISCOUNT FROM GROSS
2	8086	140 0		ADM		TDTSCT				134		ADD TO TOTAL DISCOUNTS
3	386F	141 0	NETAMT	TRA		WRKREG				111		TRANSFER NET AMOUNT
34 0	ER4B	142 0		POS		NET-P				76		POSITION TO NET AMOUNT
1	2C4D	143 0		SRJ		PNUMRC				77	3	PRINT NET AMOUNT
2	807C	144 0		ADM		INVNET				124		ADD LINE NET TO TOTAL NET
3	807E	145 0		ADM		TNET				126		ADD TO TOTAL NET SALES
35 0	4558	146 0		EX		Y		3	1			TEST IF COST APPLICABLE
1	740D	147 0		BRU		BODYIV				13	1	BRANCH TO NEXT LINE
2	6429	148 0		LSR		9						LOAD SHIFT REGISTER
3	ER59	149 0		POS		CPRC-P				90		POSITION TO COST PRICE
36 0	A632	150 0	COSTIV	NK		3		2				INDEX COST PRICE
1	2864	151 0		SRJ		CTMILL				100	2	DETERMINE IF MILLS INDEX
2	45C1	152 0		EX		A		-	1			TEST IF COST PRICE ERROR
3	7024	153 0		BRU		COSTIV				36	0	BRANCH TO INDEX COST

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
37 0	2C4E	154 0		SRJ		PT-PRC + 1			78	3	PRINT COST PRICE
		155 0		NOTE							SHIFT FOR MILLS
1	8C7A	156 0		MULR		QTY			122		MULT COST X QUANITY
2	EB61	157 0		POS		CSTX-P			98		POSITION TO COST AMOUNT
3	2C4D	158 0		SRJ		PNUMRC			77	3	PRINT COST AMOUNT
38 0	8084	159 0		ADM		TCOSTS			132		ADD LINE COST TO TOT COST
1	807D	160 0		ADM		INVCST			125		ADD TO INVOICE COST TOTAL
2	740D	161 0		BRU		BODYIV			13	1	BRANCH TO NEXT LINE
3	F628	162 0	INVTOT	PKA	2	46					ENABLE TAX & TOTAL PK
39 0	D86F	163 0		CLM		WRKREG			111		CLEAR WORKING MEMORY
1	6424	164 0		LSR		4					LOAD SHIFT REGISTER
2	2856	165 0		SRJ		SUBTOT			86	2	PRINT SUBTOTAL
3	EB3A	166 0		POS		ADDN-P			59		POSITION TO ALF TAX
40 0	2062	167 0		SRJ		CKLINE			98	0	INCREMENT LINE COUNT
1	A622	168 0		NK		2	2				XINDEX MISC TAX PERCENT
2	4500	169 0		EXZ		1					TEST IF ZERO INDEXED
3	742E	170 0		BRU		ADDONS			46	1	BRANCH TO ADDONS
41 0	4552	171 0		EX		Y	1	1			TEST FOR LAST LINE
1	2850	172 0		SRJ		CONTPG			80	2	BEGIN CONTINUATION PAGE
2	4551	173 0		EX		Y	4	1			TEST FOR LAST SIX LINES
3	285A	174 0		SRJ		ADLNCK			90	2	INCREMENT LINE COUNT
42 0	6741	175 0		SET		X	4				SET X FOR ADDONS

```
WORD SYL  OBJECT CODE  SEQ. NO.  SYM. LOC.  OP CODE  FD. LN.  A-PARAMETER LABEL  INC  B PAR  C PAR  LABEL DEC EQU  REMARKS
    1     ED01         176 0               AL          1                                          ADVANCE LEFT ONE LINE
    2     EB3A         177 0               POS         ADDN-P                      59             POSITION TO ALF TAX
    3     C054         178 0               PC          T                                          PRINT "TAX"
43  0     C041         179 0               PC          A
    1     C058         180 0               PC          X
    2     D443         181 0               PN          4                    3                     PRINT TAX AS A PERCENT
    3     C025         182 0               PC          %                                          PRINT :%:
44  0     EB4B         183 0               POS         NET-P                       76             POS TO NET COLUMN
    1     8C7C         184 0               MULR        INVNET                      124            MULT TAX % X NET
    2     2C4D         185 0               SRJ         PNUMRC                      77 3           PRINT TAX DOLLARS
    3     8083         186 0               ADM         TTAXES                      131            ADD TO TOTAL TAX DOLLARS
45  0     807C         187 0               ADM         INVNET                      124            ADD TO TOT NET INVOICE $
    1     306F         188 0               TRM         WRKREG                      111            STORE TAX DOLLARS
    2     2062         189 0               SRJ         CKLINE                      98 0           INCREMENT LINE COUNT
    3     4552         190 0               EX          Y                   1   1                  TEST IF LAST INVOICE LINE
46  0     2856         191 0               SRJ         SUBTOT                      86 2           PRINT SUB-TOTAL
    1     F620         192 0  ADDONS       PKA     1   6                                          ENABLE TOTAL INVOICE PK
    2     EB3A         193 0               POS         ADDN-P                      59             POSITION TO ADDON ALF
    3     4241         194 0               SK          X                   4   2                  TEST IF FIRST ADDON
47  0     4552         195 0               EX          Y                   1   1                  TEST IF LAST INVOICE LINE
    1     2850         196 0               SRJ         CONTPG                      80 2           BEGIN CONTINUATION PAGE
    2     4241         197 0               SK          X                   4   2                  TEST IF FIRST ADDON
```

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
	3	4551	198	0	EX		Y		4	1			TEST IF BOTTOM OF INVOICE
48	0	285A	199	0	SRJ		ADLNCK				90	2	INCREMENT LINE COUNT
	1	6741	200	0	SET		X		4				SET X4 INVOICE HAS ADDONS
	2	4652	201	0	EX		Y		1	2			TEST IF LAST INVOICE LINE
	3	2856	202	0	SRJ		SUBTOT				86	2	PRINT SUBTOTAL
49	0	2850	203	0	SRJ		CONTPG				80	2	BEGIN CONTINUATION PAGE
	1	ED01	204	0	AL		1						ADVANCE LEFT ONE LINE
	2	EB3A	205	0	POS		ADDN-P				59		POSITION TO ADDON ALF
	3	AC12	206	0	TK		18						XTYPE ADDON DESCP.
50	0	EB4B	207	0	POS		NET-P				76		POSITION TO NET COLUMN
	1	A470	208	0	NKR		7		0				XTYPE ADDON COST AMOUNT
	2	2C4D	209	0	SRJ		PNUMRC				77	3	PRINT ADDON AMOUNT
	3	45C1	210	0	EX		A		-	1			TEST IF MINUS
51	0	8080	211	0	ADM		TADDNM				128		ADD TO ADDONS MINUS
	1	41C1	212	0	SK		A		-	1			TEST IF PLUS
	2	807F	213	0	ADM		TADDNP				127		ADD TO ADDONS PLUSSES
	3	807C	214	0	ADM		INVNET				124		ADD TO TOT NET INVOICE $
52	0	4558	215	0	EX		Y		3	1			TEST IF STANDARD INVOICE
	1	7836	216	0	BRU			+ 9			54	2	BRANCH TO CHECK LINE CT
	2	EB61	217	0	POS		CSTX-P				98		POSITION TO COST COLUMN
	3	A450	218	0	NKR		5		0				XINDEX ADDON COST AMOUNT

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
53	0	2C4D	219 0		SRJ		PNUMRC				77	3	PRINT ADDON COST AMOUNT
	1	807D	220 0		ADM		INVCST				125		ADD TO TOT INV TOT COST
	2	45C1	221 0		EX		A		-	1			TEST IF MINUS
	3	8082	222 0		ADM		TADNCM				130		ADD TO COST TOTAL MINUS
54	0	41C1	223 0		SK		A		-	1			TEST IF PLUS
	1	8081	224 0		ADM		TADNCP				129		ADD TO COST TOTAL PLUS
	2	2062	225 0		SRJ		CKLINE				98	0	INCREMENT LINE COUNT
	3	742E	226 0		BRU		ADDONS				46	1	BRANCH TO NEXT ADDON
55	0	4541	227 0	TOTALI	EX		X		4	1			TEST IF ADDONS ON INVOICE
	1	2856	228 0		SRJ		SUBTOT				86	2	PRINT TOTALS
	2	4558	229 0		EX		Y		3	1			TEST IF STANDARD INVOICE
	3	7801	230 0		BRU		BEGINV				1	2	BRU TO NEXT INVOICE
56	0	387C	231 0		TRA		INVNET				124		TRANSFER TOTAL NET INV.
	1	986F	232 0		SUA		WRKREG				111		SUBT TAX FROM NET
	2	987D	233 0		SUA		INVCST				125		SUBT COST FROM NET
	3	EB56	234 0		POS		PRT&-P				87		POSITION TO PRINT PROFIT
57	0	2C4D	235 0		SRJ		PNUMRC				77	3	PRINT PROFIT AMOUNT
	1	7801	236 0		BRU		BEGINV				1	2	BRANCH TO NEXT INVOICE
	2	204D	237 0	INV-NO	SRJ		AR-POS				77	0	ADVANCE FORM POSITION
	3	C886	238 0		PA		FRSTIN				182		PRINT ALFA FRSTIN
58	0	EF02	239 0		AR		2						ADVANCE RIGHT TWO LINES
	1	EB77	240 0		POS		120						POSITION FOR PRINT

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	2	A660	241 0		NK		6		0				XINDEX INVOICE NO.
	3	D450	242 0		PN		5		0				PRINT INVOICE NUMBER
59	0	3071	243 0		TRM		INVNO			113			STORE INVOICE NO
	1	204D	244 0		SRJ		AR-POS			77	0		ADVANCE FORM POSITION
	2	C8BE	245 0		PA		DATT			190			PRINT ALFA DATT
	3	EE02	246 0		AR		2						ADVANCE RIGHT TWO LINES
60	0	E877	247 0		POS		120						POSITION FOR PRINT
	1	F073	248 0		LKBR		DATE			115			LOAD DATE BASE M.A.
	2	AD0C	249 0		TKM		12						XTYPE DATE
	3	204D	250 0		SRJ		AR-POS			77	0		ADVANCE FORM POSITION
61	0	C8BA	251 0		PA		TXRT			186			PRINT ALFA TXRT
	1	E877	252 0		POS		120						POSITION FOR PRINT
	2	EE02	253 0		AR		2						ADVANCE RIGHT TWO LINES
	3	A622	254 0		NK		2		2				XINDEX TAX RATE
62	0	D473	255 0		PN		7		3				PRINT TAX RATE
	1	3079	256 0		TRM		TAXCST			121			STORE FIRST TAX RATE
	2	7C00	257 0		BRU		INITAL			0	3		BRU TO INITIALIZE
	3	E877	258 0	DLYTOT	POS		120						POS SUMMARY HEADING
63	0	EF05	259 0		AR		5						ADVANCE RIGHT FIVE LINES
	1	C88B	260 0		PA		HEADNG			139			PRINT ALFA MESSAGE
	2	E88C	261 0		POS		141						
	3	0700	262 0		RR								PRINT DATE IN RED

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
64	0	C873	263 0		PA		DATE				115		PRINT CURRENT DATE
	1	EE02	264 0		AR		2						ADVANCE RIGHT TWO LINES
	2	EB77	265 0		POS		120						POSITION FOR PRINT
	3	C880	266 0		PA		T-GROS				176		PRINT ALFA MESSAGE
65	0	EE01	267 0		AR		1						ADVANCE RIGHT ONE LINE
	1	EB87	268 0		POS		136						POSITION FOR PRINT
	2	3885	269 0		TRA		TGROSS				133		TRANSFER TOTAL GROSS
	3	2C4D	270 0		SRJ		PNUMRC				77	3	PRINT TOTAL GROSS
66	0	5100	271 0		LIR		1		0				LOAD INDEX REGISTER
	1	5200	272 0		LIR		2		0				LOAD INDEX REGISTER
	2	5A1C	273 0	DLYNET	IIR		2		28				TEST FOR THE 7 LOOP
	3	4584	274 0		EX		T		I	1			EXECUTE IF LOOP 7
67	0	7846	275 0		BRU		FINAL				70	2	EXIT LOOP
	1	5603	276 0		ADIR		2		3				INCREMENT BY FOUR
	2	EE04	277 0		AR		4						ADVANCE RIGHT FOUR LINES
	3	EB77	278 0		POS		120						POSITION FOR PRINT
68	0	6200	279 0		MOD		2						MODIFY BY REGISTER #2
	1	C890	280 0		PA		TNS	- 4			144		PRINT ALFA MESSAGE
	2	6100	281 0		MOD		1						MODIFY BY REGISTER #1
	3	387E	282 0		TRA		TNET				126		TRANSFER NET, COST AMOUNT
69	0	EE02	283 0		AR		2						ADVANCE RIGHT TWO LINES
	1	EB87	284 0		POS		136						POSITION FOR PRINT

[redacted]

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	2	0191	285	0			PNS-	9	1				SHIFT IF MINUS
	3	C52D	286	0			PC-	-					PRINT - IF MINUS
70	0	5501	287	0			ADIR	1	1				INCREMENT INDEX REG BY 1
	1	7842	288	0			BRU	DLYNET			66	2	REPEAT LOOP
	2	EE04	289	0	FINAL		AR	4					ADVANCE RIGHT FOUR LINES
	3	EB77	290	0			POS	120					POSITION FOR PRINT
71	0	C8B2	291	0			PA	TDISC		178			
	1	EE01	292	0			AR	1					ADVANCE RIGHT ONE LINE
	2	EB87	293	0			POS	136					POSITION FOR PRINT
	3	3886	294	0			TRA	TDISCT		134			TOTAL DISCOUNTS
72	0	2C4D	295	0			SRJ	PNUMRC		77	3		PRINT TOTAL DISCOUNTS
	1	EE02	296	0			AR	2					ADVANCE RIGHT TWO LINES
	2	EB77	297	0			POS	120					POSITION FOR PRINT
	3	C88F	298	0			PA	ACT		143			ALFA MESSAGE
73	0	EE01	299	0			AR	1					ADVANCE RIGHT ONE LINE
	1	8880	300	0			ADA	TADDNM		128			ADD MINUS ADDONS
	2	887F	301	0			ADA	TADDNP		127			ADD PLUS ADDONS
	3	887E	302	0			ADA	TNET		126			ADD PRODUCT NET
74	0	2C4D	303	0			SRJ	PNUMRC		77	3		PRINT ACCT REC NET
	1	EE02	304	0			AR	2					ADVANCE RIGHT TWO LINES
	2	EB77	305	0			POS	120					POSITION FOR PRINT
	3	C891	306	0			PA	TNC		145			PRINT ALFA MESSAGE

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
75	0	EE01	307	0	AR		1						ADVANCE RIGHT ONE LINE
	1	EB87	308	0	POS		136						POSITION FOR PRINT
	2	3884	309	0	TRA		TCOSTS				132		TRANSFER TOTAL COSTS
	3	8881	310	0	ADA		TADNCP				129		ADD PLUS COST ADDONS
76	0	8882	311	0	ADA		TADNCM				130		ADD MINUS COST ADDONS
	1	2C4D	312	0	SRJ		PNUMRC				77	3	PRINT TOTAL NET COSTS
	2	EE14	313	0	AR		20						ADVANCE 20 LINES
	3	7C00	314	0	BRU		INITAL				0	3	BRU TO INITIALIZE
77	0	EE02	315	0	AR-POS		AR	2					ADVANCE RIGHT TWO LINES
	1	EB77	316	0			POS	SM-HDP			120		POS PRINT
	2	0400	317	0			SRR	1					SUBROUTINE RETURN
	3	0191	318	0	PNUMRC		PNS-	9	1				PRINT MONTERY VALUE
78	0	C52D	319	0			PC-	-					PRINT - IF MINUS
	1	0400	320	0			SRR	1					SUBROUTINE RETURN
	2	EB2A	321	0	PT-PRC		POS	SPRC-P			43		POSITION TO SELL PRICE
	3	42C2	322	0			SK	A	S	2			TEST PRICE FOR MILLS
79	0	0471	323	0			PN	7	1				PRINT WITH CENTS MASK
	1	0220	324	0			SLRO	2	0				SHIFT LEFT TWO POSITIONS
	2	45C2	325	0			EX	A	S	1			TEST PRICE FOR MILLS
	3	0472	326	0			PN	7	2				PRINT WITH MILLS MASK
80	0	307B	327	0			TRM	PRICE			123		TRANSFER SELL PRICE

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	1	0400	328 0		SRR		1						SUBROUTINE RETURN
	2	3070	329 0	CONTPG	TRM		WRKREG	+ 1		112			TEMPORARY STORE AMOUNT
	3	E80F	330 0		DC		SLDTOL	+ 7		15			ADVANCE TO CUSTOMER NAME
81	0	AC00	331 0		TK		0						CHANGE INVOICE
	1	E80C	332 0		POS		NMAD-P			13			POSITION TO PRINT
	2	C875	333 0		PA		CUSTNM			117			PRINT CUSTOMER NAME
	3	E008	334 0		LLCR		SLDTOL			8			LOAD SOLD TO LINE NO.
82	0	E90D	335 0		ALTO		SHPTOL			13			ADVANCE TO SHIP TO LINE
	1	E83F	336 0		POS		CNTP-P			64			POSITION TO PRINT
	2	C050	337 0		PC		P						PRINT "PAGE"
	3	C041	338 0		PC		A						
83	0	C047	339 0		PC		G						
	1	C045	340 0		PC		E						
	2	3872	341 0		TRA		PAGENO			114			TRANSFER PAGE NUMBER
	3	0420	342 0		PN		2		0				PRINT PAGE NO.
84	0	8F01	343 0		ADK		0		1				ADD 1 TO PAGE NO.
	1	3072	344 0		TRM		PAGENO			114			STORE PAGE NO.
	2	3871	345 0		TRA		INVNO			113			TRANSFER INVOICE NO.
	3	42D0	346 0		SKZ		2						TEST IF ZERO
85	0	9F01	347 0		SUK		0		1				SUBT 1 FROM INVOICE NO.
	1	3071	348 0		TRM		INVNO			113			STORE INVOICE NO.
	2	E914	349 0		ALTO		RIBBL			20			ADVANCE TO RIBBON LINE

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	3	285E	350	0		SRJ	DATE-J				94	2	PRINT DATE & INVOICE NO
86	0	3870	351	0		TRA	WRKREG +	1			112		TRANSFER STORED AMOUNT
	1	0400	352	0		SRR	1						SUBROUTINE RETURN
	2	3070	353	0	SUBTOT	TRM	WRKREG +	1			112		TEMPORARILY STORE AMOUNT
	3	EB4E	354	0		POS	NET-P +	3			79		POSITION FOR UNDERSCORE
87	0	C889	355	0		PA	UNDERS				137		PRINT UNDERSCORE
	1	4258	356	0		SK	Y		3	2			TEST FOR INVOICE COSTING
	2	EB64	357	0		POS	CSTX-P +	3			101		POSITION FOR UNDERSCORE
	3	C889	358	0		PA	UNDERS				137		PRINT UNDERSCORE
88	0	ED01	359	0		AL	1						ADVANCE LEFT ONE LINE
	1	EB4B	360	0		POS	NET-P				76		POSITION TO NET AMOUNT
	2	387C	361	0		TRA	INVNET				124		TRANSFER TOTAL NET AMOUNT
	3	2C4D	362	0		SRJ	PNUMRC				77	3	PRINT TOTAL NET AMOUNT
89	0	4358	363	0		SK	Y		3	3			TEST FOR INVOICE COSTING
	1	EB61	364	0		POS	CSTX-P				98		POSITION TO COST AMOUNT
	2	387D	365	0		TRA	INVCST				125		TRANSFER TOT. COST AMOUNT
	3	2C4D	366	0		SRJ	PNUMRC				77	3	PRINT TOTAL COST AMOUNT
90	0	3870	367	0		TRA	WRKREG +	1			112		TRANSFER STORED AMOUNT
	1	0400	368	0		SRR	1						SUBROUTINE RETURN
	2	5402	369	0	ADLNCK	ADIR	4		2				ADD 2 TO LINE COUNT
	3	4684	370	0		EX	T		1	2			TEST FOR LAST LINE
91	0	2850	371	0		SRJ	CONTPG				80	2	PRINT TOTAL & CONT. PAGE

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
1	0400	372 0		SRR		1					SUBROUTINE RETURN
2	5CE8	373 0		DIR		4	232				SUBT 1 FROM LINE COUNT
3	0400	374 0		SRR		1					SUBROUTINE RETURN
92 0	5300	375 0	CLRMEM	LIR		3	0				LOAD FOR COUNTER
1	6300	376 0		MOD		3					MODIFY WITH COUNTER
2	D87C	377 0		CLM		INVNET			124		CLEAR MEMORY LOCATION
3	580A	378 0		IIR		3	10				CONTROL NUMBER OF LOOPS
93 0	4484	379 0		EX		T	T	4			TEST IF LAST TOTAL
1	8F00	380 0		CLA		0	0				CLEAR ACCUMULATOR
2	204D	381 0		SRJ		AR-POS			77	0	ADVANCE FORM POSITION
3	D411	382 0		PN		1	1				PRINT ZERO
94 0	7C00	383 0		BRU		INITAL			0	3	BRU TO INTIALIZE
1	745C	384 0		BRU		CLRMEM + 1			92	1	BRU TO CLEAR NEXT TOTAL
2	ER41	385 0	DATE-J	POS		DATE-P			66		POSITION TO DATE
3	C873	386 0		PA		DATE			115		PRINT CURRENT DATE
95 0	ER4F	387 0		POS		INVNOP			80		POSITION TO INVOICE NO.
1	3871	388 0		TRA		INVNO			113		TRANSFER INVOICE NO.
2	43D0	389 0		SKZ		3					TEST FOR ZERO
3	D450	390 0		PN		5	0				PRINT INVOICE NUMBER
96 0	8F01	391 0		ADK		0	1				ADD 1 TO INVOICE NO.
1	3071	392 0		TRM		INVNO			113		STORE INVOICE NO
2	45D0	393 0		EXZ		1					TEST FOR ZERO

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
	3	AC07	394 0		TK		7						XTYPE INVOICE NO.
97	0	50EA	395 0		LIR		4		234				LOAD FOR LINE COUNT
	1	6553	396 0		RST		Y		41				RESET Y 4 AND 1
	2	E916	397 0		ALTO		BODYL				22		ADVANCE TO INVOICE BODY
	3	0400	398 0		SRR		1						SUBROUTINE RETURN
98	0	4051	399 0	CKLINE	SK		Y		4	4			TEST IF LAST SIX LINES
	1	58F8	400 0		IIR		4		248				INCREMENT FOR LINE COUNT
	2	4184	401 0		SK		T		I	1			TEST FOR 17TH LINE
	3	0400	402 0		SRR		1						SUBROUTINE RETURN
			403 0		NOTE								SET Y FOR LAST 6 LINES IN
99	0	6751	404 0		SET		Y		4				BODY OF INVOICE REACHED
	1	58FF	405 0		IIR		4		255				INCREMENT LINE COUNT
	2	0980	406 0		ALARM								WARN OPERATOR BOTTOM INV.
	3	4584	407 0		EX		T		I	1			TEST FOR LAST LINE
100	0	6752	408 0		SET		Y		1				SET Y1 FOR CONT. PAGE
	1	0400	409 0		SRR		1						SUBROUTINE RETURN
	2	306F	410 0	CTMILL	TRM		WRKREG				111		TRANSFER PRICE TO M.A.
	3	0200	411 0		SLRO		13		0				SHIFT OFF DOLLARS & CENTS
101	0	4700	412 0		EXZ		3						TEST IF ZERO MILLS
	1	386F	413 0		TRA		WRKREG				111		TRANSFER PRICE
	2	0202	414 0		SLRO		0		2				REPOSITION FOR CENTS ONLY
	3	0400	415 0		SRR		1						SUBROUTINE RETURN

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
102	0	386F	416 0		TRA		WRKREG			111			TRANSFER PRICE
	1	0207	417 0		SLRO		0		7				SHIFT OFF 7 DIGITS
			418 0		NOTE								TEST IF MORE THAN SEVEN
	2	4300	419 0		SKZ		3						DIGITS WERE INDEXED
	3	67C1	420 0		SET		A		-				YES, SET - FLAG
103	0	0980	421 0		ALARM								WARN OPERATOR ERROR PRICE
	1	0400	422 0		SRR		1						SUBROUTINE RETURN
	2	386F	423 0		TRA		WRKREG			111			TRANSFER PRICE
			424 0		NOTE								SET FLAG TO INDICATE
	3	67C2	425 0		SET		A		S				CENTS AND MILLS
104	0	0400	426 0		SRR		1						SUBROUTINE RETURN
	1	6558	427 0	IVCOST	RST		Y		3				RESET STANDARD INV. FLAG
	2	7801	428 0		BRU		BEGINV			1	2		BRU TO INVOICE ROUTINE
	3	0000			STOP								** INSERTED BY ASSEM. **
			429 0		WORD								PROGRAM KEY TABLE
105	0	7839	430 0	PKTABL	BRU		INV-NO			57	2		BRU LOAD DATE INV NO TAX
	1	7C3E	431 0		BRU		DLYTOT			62	3		BRU TO PRINT DAILY TOTALS
	2	7C26	432 0		BRU		INVTOT			38	3		BRU TO SUBTOTAL
	3	3879	433 0		TRA		TAXCST			121			TRANSFER TAX PERCENT
106	0	7468	434 0		BRU		IVCOST			104	1		BRU TO COST INVOICE
	1	7037	435 0		BRU		TOTALI			55	0		BRU TO TOTAL INVOICE
	2	7C00	436 0		BRU		INITAL			0	3		BRU TO INITIALIZE

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
3	705C	437 0		BRU		CLRMEM				92 0		BRU TO CLEAR MEMORY
		438 0		PAGE								

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
107 0		439 0	MASKTB	MASK	15	Z77,ZZZ,ZZZ,ZZZ					NUMERIC
107 0	E666										** INSERTED BY ASSEM. **
1	6F66										** INSERTED BY ASSEM. **
2	66E6										** INSERTED BY ASSEM. **
3	0333										** INSERTED BY ASSEM. **
108 0		440 0		MASK	16	Z.7ZZ,ZZZ,ZZZ.DD					MONETARY ZERO PRINT
108 0	6697										** INSERTED BY ASSEM. **
1	66E6										** INSERTED BY ASSEM. **
2	E66E										** INSERTED BY ASSEM. **
3	0333										** INSERTED BY ASSEM. **
109 0		441 0		MASK	15	Z7,ZZZ,ZZZ.CCCC					MONETARY WITH MILLS
109 0	8000										** INSERTED BY ASSEM. **
1	E666										** INSERTED BY ASSEM. **
2	6F66										** INSERTED BY ASSEM. **
3	0333										** INSERTED BY ASSEM. **
110 0		442 0		MASK	16	Z77FZZZZZZZZ,XS					HUNDREDS PERCENT $ NO.
110 0	66C2										** INSERTED BY ASSEM. **
1	6666										** INSERTED BY ASSEM. **
2	6166										** INSERTED BY ASSEM. **
3	0666										** INSERTED BY ASSEM. **
111 0		443 0	WRKREG	REG		2					GENERAL WORK REGISTER
113 0		444 0	INVNO	REG		1					INVOICE NUMBER
114 0		445 0	PAGENO	REG		1					PAGE NUMBER

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
115 0		446 0	DATE	REG		2						CURRENT DATE
117 0		447 0	CUSTNM	REG		4						CUSTOMER NAME
121 0		448 0	TAXCST	REG		1						TAX CONSTANT
122 0		449 0	QTY	REG		1						INVOICE QUANITY
123 0		450 0	PRICE	REG		1						INVOICE PRICE
124 0		451 0	INVNET	REG		1						INVOICE NET TOTAL
125 0		452 0	INVCST	REG		1						INVOICE COST TOTAL
126 0		453 0	TNET	REG		1						TOTAL NET SALES
127 0		454 0	TADONP	REG		1						TOTAL PLUS ADDONS
128 0		455 0	TADONM	REG		1						TOTAL MINUS ADDONS
129 0		456 0	TADNCP	REG		1						TOTAL PLUS COST ADDONS
130 0		457 0	TADNCM	REG		1						TOTAL MINUS ADDONS
131 0		458 0	TTAXES	REG		1						TOTAL TAXES
132 0		459 0	TCOSTS	REG		1						TOTAL COSTS
133 0		460 0	TGROSS	REG		1						TOTAL GROSS SALES
134 0		461 0	TDISCT	REG		1						TOTAL DISCOUNTS
135 0		462 0	TEST	NUM	4	5000						TEST VALUE 5000
135 0	5000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **
2	0000											** INSERTED BY ASSEM. **
3	0000											** INSERTED BY ASSEM. **
136 0		463 0	SAME	ALF	4	SAME						
136 0	0000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 024

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	R PAR	C PAR	LABEL DEC	EQU	REMARKS
	2	4045											** INSERTED BY ASSEM. **
	3	5341											** INSERTED BY ASSEM. **
137	0		464 0	UNDERS	ALF	11	----------						UNDERSCORE
137	0	5F5F											** INSERTED BY ASSEM. **
	1	5F5F											** INSERTED BY ASSEM. **
	2	5F5F											** INSERTED BY ASSEM. **
	3	5F5F											** INSERTED BY ASSEM. **
138	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	5F00											** INSERTED BY ASSEM. **
	3	5F5F											** INSERTED BY ASSEM. **
139	0		465 0	HEADNG	ALF	24	DAILY TOTALS FOR....						
139	0	2054											** INSERTED BY ASSEM. **
	1	4C59											** INSERTED BY ASSEM. **
	2	4149											** INSERTED BY ASSEM. **
	3	2044											** INSERTED BY ASSEM. **
140	0	464F											** INSERTED BY ASSEM. **
	1	5320											** INSERTED BY ASSEM. **
	2	414C											** INSERTED BY ASSEM. **
	3	4F54											** INSERTED BY ASSEM. **
141	0	2020											** INSERTED BY ASSEM. **
	1	2F20											** INSERTED BY ASSEM. **

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	2	2F2E											** INSERTED BY ASSEM. **
	3	522E											** INSERTED BY ASSEM. **
142	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	0000											** INSERTED BY ASSEM. **
	3	0000											** INSERTED BY ASSEM. **
143	0		466	0 ACT	ALF	12	ACC REC NET						
143	0	4543											** INSERTED BY ASSEM. **
	1	2052											** INSERTED BY ASSEM. **
	2	4343											** INSERTED BY ASSEM. **
	3	2041											** INSERTED BY ASSEM. **
144	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	4554											** INSERTED BY ASSEM. **
	3	204E											** INSERTED BY ASSEM. **
145	0		467	0 TNC	ALF	16	TOTAL NET COST						
145	0	4C20											** INSERTED BY ASSEM. **
	1	5441											** INSERTED BY ASSEM. **
	2	544F											** INSERTED BY ASSEM. **
	3	2020											** INSERTED BY ASSEM. **
146	0	5354											** INSERTED BY ASSEM. **
	1	434F											** INSERTED BY ASSEM. **

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC EQU	REMARKS
	2	5420										** INSERTED BY ASSEM. **
	3	4F45										** INSERTED BY ASSEM. **
147	0	0000										** INSERTED BY ASSEM. **
	1	0000										** INSERTED BY ASSEM. **
	2	0000										** INSERTED BY ASSEM. **
	3	0000										** INSERTED BY ASSEM. **
148	0		468 0	TNS	ALF	24	TOTAL NET SALES					
148	0	4F45										** INSERTED BY ASSEM. **
	1	4C20										** INSERTED BY ASSEM. **
	2	5441										** INSERTED BY ASSEM. **
	3	544F										** INSERTED BY ASSEM. **
149	0	5320										** INSERTED BY ASSEM. **
	1	4C45										** INSERTED BY ASSEM. **
	2	5341										** INSERTED BY ASSEM. **
	3	5420										** INSERTED BY ASSEM. **
150	0	2020										** INSERTED BY ASSEM. **
	1	2020										** INSERTED BY ASSEM. **
	2	2020										** INSERTED BY ASSEM. **
	3	2020										** INSERTED BY ASSEM. **
151	0	0000										** INSERTED BY ASSEM. **
	1	0000										** INSERTED BY ASSEM. **
	2	0000										** INSERTED BY ASSEM. **

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	3	0000											** INSERTED BY ASSEM. **
152	0		469	0	ALF	24	TOTAL PLUS ADDONS						
152	0	504C											** INSERTED BY ASSEM. **
	1	4C20											** INSERTED BY ASSEM. **
	2	5441											** INSERTED BY ASSEM. **
	3	544F											** INSERTED BY ASSEM. **
153	0	4F4E											** INSERTED BY ASSEM. **
	1	4444											** INSERTED BY ASSEM. **
	2	2041											** INSERTED BY ASSEM. **
	3	5553											** INSERTED BY ASSEM. **
154	0	2020											** INSERTED BY ASSEM. **
	1	2020											** INSERTED BY ASSEM. **
	2	2020											** INSERTED BY ASSEM. **
	3	5320											** INSERTED BY ASSEM. **
155	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	0000											** INSERTED BY ASSEM. **
	3	0000											** INSERTED BY ASSEM. **
156	0		470	0	ALF	24	TOTAL MINUS ADDONS						
156	0	4D49											** INSERTED BY ASSEM. **
	1	4C20											** INSERTED BY ASSEM. **
	2	5441											** INSERTED BY ASSEM. **

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	3	544F											** INSERTED BY ASSEM. **
157	0	444F											** INSERTED BY ASSEM. **
	1	4144											** INSERTED BY ASSEM. **
	2	5320											** INSERTED BY ASSEM. **
	3	4F55											** INSERTED BY ASSEM. **
158	0	2020											** INSERTED BY ASSEM. **
	1	2020											** INSERTED BY ASSEM. **
	2	2020											** INSERTED BY ASSEM. **
	3	4E53											** INSERTED BY ASSEM. **
159	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	0000											** INSERTED BY ASSEM. **
	3	0000											** INSERTED BY ASSEM. **
160	0		471	0	ALF	24	TOTAL PLUS COST ADDONS						
160	0	504C											** INSERTED BY ASSEM. **
	1	4C20											** INSERTED BY ASSEM. **
	2	5441											** INSERTED BY ASSEM. **
	3	544F											** INSERTED BY ASSEM. **
161	0	5420											** INSERTED BY ASSEM. **
	1	4F53											** INSERTED BY ASSEM. **
	2	2043											** INSERTED BY ASSEM. **
	3	5553											** INSERTED BY ASSEM. **

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
162 0	2020											** INSERTED BY ASSEM. **
1	4F53											** INSERTED BY ASSEM. **
2	444F											** INSERTED BY ASSEM. **
3	4144											** INSERTED BY ASSEM. **
163 0	0000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **
2	0000											** INSERTED BY ASSEM. **
3	0000											** INSERTED BY ASSEM. **
164 0		472 0		ALF	24	TOTAL MINUS COST ADDONS						
164 0	4D49											** INSERTED BY ASSEM. **
1	4C20											** INSERTED BY ASSEM. **
2	5441											** INSERTED BY ASSEM. **
3	544F											** INSERTED BY ASSEM. **
165 0	5354											** INSERTED BY ASSEM. **
1	434F											** INSERTED BY ASSEM. **
2	5320											** INSERTED BY ASSEM. **
3	4E55											** INSERTED BY ASSEM. **
166 0	5320											** INSERTED BY ASSEM. **
1	4F4E											** INSERTED BY ASSEM. **
2	4444											** INSERTED BY ASSEM. **
3	2041											** INSERTED BY ASSEM. **

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
167 0	0000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **
2	0000											** INSERTED BY ASSEM. **
3	0000											** INSERTED BY ASSEM. **
168 0		473 0		ALF	24	TOTAL TAXES						
168 0	5441											** INSERTED BY ASSEM. **
1	4020											** INSERTED BY ASSEM. **
2	5441											** INSERTED BY ASSEM. **
3	544F											** INSERTED BY ASSEM. **
169 0	2020											** INSERTED BY ASSEM. **
1	2020											** INSERTED BY ASSEM. **
2	5320											** INSERTED BY ASSEM. **
3	5845											** INSERTED BY ASSEM. **
170 0	2020											** INSERTED BY ASSEM. **
1	2020											** INSERTED BY ASSEM. **
2	2020											** INSERTED BY ASSEM. **
3	2020											** INSERTED BY ASSEM. **
171 0	0000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **
2	0000											** INSERTED BY ASSEM. **
3	0000											** INSERTED BY ASSEM. **
172 0		474 0		ALF	24	TOTAL COSTS						

```
WORD SYL  OBJECT CODE   SEQ. NO.   SYM. LOC.   OP CODE   FD. LN.   A-PARAMETER LABEL   B INC   C PAR   LABEL PAR   DEC EQU   REMARKS
172 0     434F                                                                                    ** INSERTED BY ASSEM. **
    1     4C20                                                                                    ** INSERTED BY ASSEM. **
    2     5441                                                                                    ** INSERTED BY ASSEM. **
    3     544F                                                                                    ** INSERTED BY ASSEM. **
173 0     2020                                                                                    ** INSERTED BY ASSEM. **
    1     2020                                                                                    ** INSERTED BY ASSEM. **
    2     5320                                                                                    ** INSERTED BY ASSEM. **
    3     5354                                                                                    ** INSERTED BY ASSEM. **
174 0     2020                                                                                    ** INSERTED BY ASSEM. **
    1     2020                                                                                    ** INSERTED BY ASSEM. **
    2     2020                                                                                    ** INSERTED BY ASSEM. **
    3     2020                                                                                    ** INSERTED BY ASSEM. **
175 0     0000                                                                                    ** INSERTED BY ASSEM. **
    1     0000                                                                                    ** INSERTED BY ASSEM. **
    2     0000                                                                                    ** INSERTED BY ASSEM. **
    3     0000                                                                                    ** INSERTED BY ASSEM. **
176 0               475 0     T-GROS    ALF     14        TOTAL GROSS
176 0     4C20                                                                                    ** INSERTED BY ASSEM. **
    1     5441                                                                                    ** INSERTED BY ASSEM. **
    2     544F                                                                                    ** INSERTED BY ASSEM. **
    3     2020                                                                                    ** INSERTED BY ASSEM. **
177 0     0000                                                                                    ** INSERTED BY ASSEM. **
```

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	1	5320											** INSERTED BY ASSEM. **
	2	4F53											** INSERTED BY ASSEM. **
	3	4752											** INSERTED BY ASSEM. **
178	0		476 0	TDISC	ALF	24	TOTAL DISCOUNTS						
178	0	2044											** INSERTED BY ASSEM. **
	1	414C											** INSERTED BY ASSEM. **
	2	4F54											** INSERTED BY ASSEM. **
	3	2054											** INSERTED BY ASSEM. **
179	0	5453											** INSERTED BY ASSEM. **
	1	554E											** INSERTED BY ASSEM. **
	2	434F											** INSERTED BY ASSEM. **
	3	4953											** INSERTED BY ASSEM. **
180	0	2020											** INSERTED BY ASSEM. **
	1	2020											** INSERTED BY ASSEM. **
	2	2020											** INSERTED BY ASSEM. **
	3	2020											** INSERTED BY ASSEM. **
181	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	0000											** INSERTED BY ASSEM. **
	3	0000											** INSERTED BY ASSEM. **
182	0		477 0	FRSTIN	ALF	24	STARTING INVOICE NO.						
182	0	494E											** INSERTED BY ASSEM. **

```
WORD SYL  OBJECT CODE  SEQ. NO.  SYM. LOC.  OP CODE  FD. LN.  A-PARAMETER LABEL  INC  B PAR  C PAR  LABEL DEC  LABEL EQU  REMARKS

     1    5254                                                                                  ** INSERTED BY ASSEM. **
     2    5441                                                                                  ** INSERTED BY ASSEM. **
     3    2053                                                                                  ** INSERTED BY ASSEM. **

183  0    4943                                                                                  ** INSERTED BY ASSEM. **
     1    564F                                                                                  ** INSERTED BY ASSEM. **
     2    494E                                                                                  ** INSERTED BY ASSEM. **
     3    4720                                                                                  ** INSERTED BY ASSEM. **

184  0    2020                                                                                  ** INSERTED BY ASSEM. **
     1    2E20                                                                                  ** INSERTED BY ASSEM. **
     2    4E4F                                                                                  ** INSERTED BY ASSEM. **
     3    4520                                                                                  ** INSERTED BY ASSEM. **

185  0    0000                                                                                  ** INSERTED BY ASSEM. **
     1    0000                                                                                  ** INSERTED BY ASSEM. **
     2    0000                                                                                  ** INSERTED BY ASSEM. **
     3    0000                                                                                  ** INSERTED BY ASSEM. **

186  0         478  0   TXRT      ALF     24     TAX RATE
186  0    4154                                                                                  ** INSERTED BY ASSEM. **
     1    2052                                                                                  ** INSERTED BY ASSEM. **
     2    4158                                                                                  ** INSERTED BY ASSEM. **
     3    2054                                                                                  ** INSERTED BY ASSEM. **

187  0    2020                                                                                  ** INSERTED BY ASSEM. **
     1    2020                                                                                  ** INSERTED BY ASSEM. **
```

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
	2	2020											** INSERTED BY ASSEM. **
	3	4520											** INSERTED BY ASSEM. **
188	0	2020											** INSERTED BY ASSEM. **
	1	2020											** INSERTED BY ASSEM. **
	2	2020											** INSERTED BY ASSEM. **
	3	2020											** INSERTED BY ASSEM. **
189	0	0000											** INSERTED BY ASSEM. **
	1	0000											** INSERTED BY ASSEM. **
	2	0000											** INSERTED BY ASSEM. **
	3	0000											** INSERTED BY ASSEM. **
190	0		479	0	DAIT	ALF	24	CURRENT DATE					
190	0	4F54											** INSERTED BY ASSEM. **
	1	5245											** INSERTED BY ASSEM. **
	2	5552											** INSERTED BY ASSEM. **
	3	2043											** INSERTED BY ASSEM. **
191	0	2020											** INSERTED BY ASSEM. **
	1	4520											** INSERTED BY ASSEM. **
	2	4154											** INSERTED BY ASSEM. **
	3	2044											** INSERTED BY ASSEM. **
192	0	2020											** INSERTED BY ASSEM. **
	1	2020											** INSERTED BY ASSEM. **
	2	2020											** INSERTED BY ASSEM. **

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
3	2020											** INSERTED BY ASSEM. **
193 0	0000											** INSERTED BY ASSEM. **
1	0000											** INSERTED BY ASSEM. **
2	0000											** INSERTED BY ASSEM. **
3	0000											** INSERTED BY ASSEM. **
		480 0	SLDTOL	DEF		8						SOLD TO LINE
		481 0	SHPTOL	DEF		13						SHIP TO LINE
		482 0	RIBBL	DEF		20						RIBBON LINE
		483 0	BODYL	DEF		22						BODY OF INVOICE LINE
		484 0	NMAD-P	DEF		13						POS. NAME ADDRESS
		485 0	TERM-P	DEF		6						POS TERMS
		486 0	ORDNOP	DEF		19						POS ORDER NUMBER
		487 0	CUSNOP	DEF		31						POS CUSTOMER NUMBER
		488 0	SLDBYP	DEF		42						POS SOLD BY NAME
		489 0	SHPVIP	DEF		56						POS SHIP VIA
		490 0	DATE-P	DEF		66						POS DATE
		491 0	INVNOP	DEF		80						POS INVOICE NUMBER
		492 0	PRDCOP	DEF		5						POS PRODUCT NUMBER
		493 0	QTY-P	DEF		7						POS QUANITY
		494 0	DESC-P	DEF		22						POS DESCRIPTION
		495 0	SPRC-P	DEF		43						POS SELL PRICE
		496 0	PERU-P	DEF		55						POS PER UNIT COLUMN
		497 0	GRS-P	DEF		56						POS GROSS AMOUNT
		498 0	DISC-P	DEF		68						POS DISCOUNT PERCENT

PROGRAM ID. - DATE RUN 3/26/70 TIME - 12:48 VERSION 02-01-70 PAGE 036

WORD SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	EQU	REMARKS
		499 0	NET-P	DEF		76						POS NET AMOUNT
		500 0	CPRC-P	DEF		90						POS COST PRICE
		501 0	CSTX-P	DEF		98						POS COST AMOUNT
		502 0	ADDN-P	DEF		59						POS ALPHA ADDONS
		503 0	PRT%-P	DEF		87						POS PROFIT/LOSS %
		504 0	CNTP-P	DEF		64						POS TO CONT. PAGE
		505 0	SM-HDP	DEF		120						POS MISC ENTRIES RGHT
		506 0	SM-CTP	DEF		136						POS SUMMARY COST
		507 0		NOTE								X3 NO DISCOUNT LINE
		508 0		NOTE								X4 ADDONS ON INVOICE
		509 0		NOTE								Y1 START CONT. PAGE
		510 0		NOTE								Y3 STANDARD INVOICE
		511 0		NOTE								Y4 LAST 6 INVOICE LINES
		512 0		NOTE								X INDICATES MANUAL INDEX
		513 0		END								END OF JOB

Burroughs TODD DIVISION SYSTEM SET

INVOICE

Burroughs

DEMONSTRATING FORM

SOLD TO : ACME TOOL AND DIE
4444 MAIN STREET
BAKEWELL, OHIO
48122

SHIP TO : SAME

TERMS	ORDER NO.	CUSTOMER NO.	SOLD BY	SHIP VIA	DATE	INVOICE NO.
COD	23-A67	ATD-900	MLS	RAIL	MAR 15 1970	105

CODE	QUANTITY	DESCRIPTION	PRICE	UNIT	GROSS	DISCOUNT	NET	COST PRICE	COST EXTENSION
6	10	ASST NUTS AND BOLTS WITH WASHERS	1.00	EA	10.00		10.00	.10	1.00
12	5	REVERSIBLE RATCHETS	11.50	EA	57.50		57.50	4.50	22.50
121	100	ASST SIZES SOCKETS	1.20	EA	120.00		120.00	.67	67.00
205	6	TOOL CHESTS	4.75	EA	28.50		28.50	2.19	13.08
99	5,000	NONLEAK RUBBER RUBBER-GASKETS	2.00	C	100.00	23 %	77.00	.02	1.00
75	25.000	COLD CHISELS	60.00	C	15,000.00	12 %	13,200.00	49.00	12,250.00
							13,493.00		12,354.58
					TAX 9.12%		1,230.56		
							14,723.56	1,138.42	12,354.58

234567890

PRINTED IN U.S. AMERICA

1033651

CROSS REFERENCE TABLE BETWEEN PROGRAM DEFINITION CHART SEQUENCE NUMBER AND ASSEMBLER III OUTPUT SEQUENCE NUMBER

FUNCTION	PROGRAM DEFINITION CHART SEQUENCE NUMBERS	ASSEMBLER III OUTPUT SEQUENCE NUMBERS
Invoice	1.	2410 - 2430
Date	2.	2480 - 2490
Tax Rate	3.	2540 - 2550
Clear Daily Totals	4.	3750 - 3840
Choice of Invoice	5.	50 - 100
Sold-to and Ship-to Information	6. 7.	160 - 420
Terms	8.	440 - 450
Order Number	9.	460 - 470
Customer Number	10.	480 - 490
Sold-by-Information	11.	500 - 510
Ship-via-Information	12.	520 - 530
Print Date	13.	560, 3850 - 3860
Print Invoice Number	14.	3870 - 3940
Product Number	15.	650 - 720
Quantity	16.	800 - 820
Product Description	17.	880 - 890
Sell Price	18.	950 - 1220
Unit	19.	1060, 1110, 1220
Gross	20.	1230 - 1240
Discount	21.	1290 - 1350
Net Amount	22.	1410 - 1430
Cost Price	23.	1490 - 1500
Cost Amount	24.	1560 - 1580
Invoice Subtotal	25.	1620 - 1650
Tax Per Cent	26.	1666 - 1682
Tax Amount	27.	1840
Add Ons	28.	1920 - 2060
Cost Add On	29.	2070 - 2260
Invoice Total	30.	1620 -
Automatic Continuation Pages	31.	3290 - 3520
Calculate and Print Profit	32.	2310 - 2350
Print Totals	33.	2580 - 3140

SECTION 5

ASSEMBLERS

FUNCTIONAL DESCRIPTION OF BASIC ASSEMBLERS

An assembler is a program or system of programs which prepares a machine language program from a symbolic language program by substituting absolute operation codes for symbolic operation codes and absolute or relocatable addresses for symbolic address.

Versions of the Series L/TC Assembler are available for several of Burroughs Computer systems. The processing time and operation is different in varying degrees from one version to the other although the functions of all versions are basically the same. These functions include error detection, preparation of object program media, symbolic and object program listings, and other operating and debugging aids. Input to each version of the L/TC Assembler consists of GP 300 instructions in the format specified by the Burroughs Assembler Coding Form (MKTG 2296) (See Section 1 of this manual).

ASSEMBLER I – SERIES L/TC PAPER TAPE VERSION

Assembler I is a two phase (two pass) version of the Series L/TC Assembler which operates on Series L/TC equipment. Each phase is a separate program and must be loaded prior to its operation. The Series L/TC keyboard is used for Phase I input. The output consists of a Phase I listing as well as a symbolic paper tape. This symbolic paper tape is then used as input for Phase II. Phase II output consists of a Phase II assembler listing and an object program tape.

EQUIPMENT REQUIRED

Series L/TC with full user memory – Style A 581 Paper Tape Reader and Style A 562 Paper Tape Punch. Firmware Set No. 2100100100 or No. 2100100200. The assembler is designed to function with the above standard Firmware Sets, which implement the GP 300 language with paper tape input/output.

Phase I of the assembler overlays the multiply and divide micros, and Phase II restores them.

If only Phase I of the assembler program is used, Phase II must be loaded to restore the original firmware micros before attempting to run application programs.

PHASE I

Phase I of Assembler I operates under 3 modes: 1) Keyboard Mode, 2) Correction Mode, and 3) Continuation Mode. Under Keyboard Mode, the symbolic instructions are entered on the Series L/TC keyboard, a Label Table is built up in memory, a Phase I listing is prepared on the printer, and a symbolic paper tape is punched. Under Correction Mode, instructions may be changed, added, or deleted in the symbolic paper tape. Correction Mode allows the Phase I assembly process to be resumed after an interruption. Phase I also has diagnostic facilities for the detection and indication of errors.

PHASE I – INPUT

The input of Phase I of the assembler program is comprised of the labels, symbolic operation codes, parameters and remarks which are entered sequentially via the keyboard or the tape reader (in the case of continuation mode or correction mode).

PHASE I – OPERATING INSTRUCTIONS

In operating Assembler I, pin fed continuous forms, a minimum of 11-3/4 inches in width, must be used. The left edge of the pin fed form should be at position 5 on the scale and the positioned forms are visible along the bottom form bail. Both Pass I and Pass II object program tapes include their own firmware. Therefore, when loading the assembler programs, all 32 tracks of main memory (words 0-1023) must be unprotected.

1. Via Memory Loader Device: Load in normal manner. (See Section 6 of this manual for specific instructions.)
2. Via Paper Tape Reader:
   a. Load "Memory Load P.T. Reader" into Utility Track with normal load procedure.
   b. From Ready Mode, depress PKA 3 – Utility – and load Pass 1 of Assembler 1 through tape reader.
   c. Execute Assembler Pass 1. See below.
   d. Upon completion of all Pass 1 assemblies, depress PKA 3 from Ready Mode to load Assembler Pass 2. Pass 1 assembly does not destroy the Reader Load Routine in the Utility Track.
   e. Execute Assembler Pass 2. See below.
   f. Upon completion of all Pass 2 assemblies depress PKA 3 from Ready Mode to load in appropriate Main Memory Firmware through Tape Reader, prior to loading and executing any user programs.*

Start

Depress PKA 1, the "START" Key.

The program will stop at a Numeric Keyboard (NK) instruction with three PK's enabled.

The three enabled PK's are:

PKA 2 KEYBOARD MODE OF OPERATION

PKA 3 CORRECTION MODE OF OPERATION

PKA 4 CONTINUATION MODE

OCK's The use of any OCK will allow 15 inches of leader tape (sprocket holes) to be punched and an automatic return to the initial keyboard (NK) instruction.

1. When "MEMORY" prints, enter the number of words of user memory. No entry assumes 512 words.
2. When "EXTMEM" prints, depress OCK 2, 3, 4.
3. When "PAGE 51" prints, depress OCK 1 for 51 lines/page or OCK 2, 3, 4 if 66 line/page are desired.

***Keyboard Modifiers for the Commercial Keyboard may be loaded immediately after loading Pass I.**

Keyboard Mode

Depress PKA 2 to enter the keyboard mode. The program will stop with the numeric keyboard enabled to allow the operator to enter the total words of memory intended for the object program.

Use any OCK to terminate the instruction. The program will then stop in the INSTRUCTION FIELD with the Alpha Keyboard enabled. Failure to enter the total words of memory will inhibit the operator from continuing at the INSTRUCTION FIELD position.

Instruction Field

Type the Mnemonic Op Code or Pseudo Op Code, listed on the symbolic program form.

The following choices are available to the operator:

OCK 2 – Program will return to and stop in the LABEL FIELD. This may be done before or after the entry of the Mnemonic.

OCK 4 – Program will stop in the parameter field, but a stop in the remarks field will be enforced before the entry of the instruction is completed.

OCK 1-3 – Program will stop in the parameter field without an enforced stop in the remarks field.

PKA 1 – Partial Phase I Halt. The use of PKA 1 will permit Phase I to be halted at any time. A special code is punched in the source tape instead of the pseudo operation code END. The label table is printed and punched in the source tape at each stop or "breakpoint." The label table punched at the conclusion of each segment of assembly is updated and all inclusive to that point. In addition, the last operation sequence number is printed and punched. There are two possibilities of continuing the assembly of the program. The first possibility is that the next section of the program will be assembled before the status of the assembler program in the machine has been disturbed. In this case, it is only necessary to enter the continuation mode and proceed. The second possibility is that the continuation will be at some later date when all current information in the system has certainly been destroyed.

In this case, it is necessary to load the Phase I assembler program and the label table along with the ending sequence number, both of which were printed and punched at the time of the "breakpoint," enter the continuation mode and proceed.

The partial Phase I halt, or breakpoint makes it possible to assemble large programs in sections.

The special code used for the breakpoint makes it possible to use small sections of Phase I source tape for input to Phase II. The breakpoint code will halt Phase II at a keyboard instruction, as described in Phase II operation, and the use of any OCK will permit Phase II to continue.

PKA 8 – Will print "ERROR" in red at left of sequence number column, the form will space and the program will stop in the Instruction Field for re-entry.

The entry of an Invalid Mnemonic will function in the same manner as the depression of PKA 8.

The typing of the Pseudo-Op word END will cause the program to enter a routine where the label table will be printed and punched out. The program will then allow the system to return to the READY MODE.

Label Field

Type in the Label – a maximum of 6 characters is permissible. The first character must be an Alpha character. A maximum of 139 labels may be used.

OCK's – Use of any OCK to terminate the field will cause the program to skip to the PARAMETER FIELD IF THE INSTRUCTION FIELD has been previously entered. If not, the program will stop in the INSTRUCTION FIELD.

Use of OCK 4 will also enforce a stop in the REMARKS FIELD before the line is completed.

PKA 8 – Will print "ERROR" in red at left of sequence number column, the form will space the program and the program will stop in the Instruction Field for line re-entry.

If a duplicate label is entered, the same function will occur as if PKA 8 had been depressed.

Parameter Field

The Parameter Field may actually be a 1, 2 or 3 field entry, depending on the Mnemonic entered in the Instruction Field. Either the Alpha Keyboard or the Numeric Keyboard will be enabled at this time, also depending on the Mnemonic.

OCK's – Use of OCK 2 before the entry will change the entry mode from ALPHA to NUMERIC or from NUMERIC to ALPHA; however, the program will allow this switch only if the Mnemonic permits it. (i.e., some Mnemonics may only have a LABEL).

ALPHA ENTRY – Enter the appropriate Alpha Characters. A maximum of 6 characters is permitted on labels.

NUMERIC ENTRY – Enter appropriate numeric digits. Where a zero entry is not permitted or where the numeric entry exceeds the value permitted by the Mnemonics, the program validation routine will re-initiate a numeric keyboard instruction until the operator indexes a valid entry.

OCK 1 – The program will stop in the next PARAMETER FIELD if the Mnemonic calls for another field entry. If the parameter field entry is the ending parameter field entry, the program will print the sequence number, the form will space and the program will stop in the INSTRUCTION FIELD for the next entry. If OCK 4 had been used in any previous entry position, after printing the sequence number, the program will stop in the REMARKS FIELD before ending the line entry.

OCK 2 – Depression of OCK 2 will activate the alternate keyboard when the instruction allows both absolute and symbolic parameter entries. For example, if the numeric keyboard is active, depression of OCK 2 will cause the alphanumeric keyboard to become active if the choice is available. In all other instances the key will function the same as OCK 1.

OCK 3 – The program will stop to permit entry of a +/– increment (numeric).

OCK 4 – On the ending Parameter Field entry, after printing the sequence number, the program will stop in REMARKS FIELD before ending the line entry.

PKA 8 – Use of this PK will print "ERROR" in red at the left of the sequence number column, the form will space and the program will stop in the INSTRUCTION FIELD for re-entry.

If an Invalid Alpha key has been used, the same function will occur as if PKA 8 had been depressed.

+/– Increment

The numeric keyboard is enabled. The numeric entry may be up to 255. Use of the RE key prior to termination, will permit a MINUS value; otherwise, the entry will be positive.

OCK 1, 2, 3 – These OCK's will print the sequence number, space the form and stop in the INSTRUCTION FIELD for the next line entry. If OCK 4 has been used previously, at any time in the symbolic entry, the sequence number will be printed and the program will stop in the REMARKS FIELD.

OCK 4 – Enforces a stop in the REMARKS FIELD.

PKA 8 – This PK will print "ERROR" in red at left of the sequence number column, the form will space and the program will stop in the INSTRUCTION FIELD for re-entry.

Remarks Field

Typing of up to 25 Alpha characters for remarks is permitted. The entry of a 26th character will result in a keyboard Error condition. The program will be halted. The RESET key must be used to correct the error condition and an OCK used to terminate REMARKS FIELD correctly. Remarks are not punched into the output tape until all typing is completed and the instruction terminated by the use of an OCK. The form will space and the program will stop in the INSTRUCTION FIELD for the next entry.

Alf Pseudo-Instruction

The entry of the pseudo-op ALF will permit the entry of up to 24 alpha characters as a constant. The entry of from 1 to 23 characters followed by OCK termination will cause the program to allocate the correct number of words for the message. The program will then stop in the INSTRUCTION FIELD for the next entry. The entry of exactly 24 characters and termination will cause the program to allocate the words and, in addition, the program will automatically print ALF in the INSTRUCTION FIELD on the next line and then stop for an additional alpha constant entry. The entry of a 25th character will result in a keyboard error condition. The RESET key must be used to correct the error condition and permit the proper termination by an OCK. However, the word ALF will still print in the INSTRUCTION FIELD with a stop to allow for an additional alpha-constant entry.

Continuation Mode

In addition to loading the Assembler program tape Phase I, using the standard program load procedures, the label table must also be loaded into memory. The tape perforator must be turned on and sufficient leader tape (sprocket holes only) punched. The RESET KEY will return the machine to the READY MODE.

PKA 4 – This will cause the sequence number printed out with the first line of entry and to be in proper sequence with the last sequence number from the previous section of tape, prior to the

breakpoint. The program will then enter the KEYBOARD MODE portion of the Assembler program, Phase I for continuation.

Correction Mode

Depression of PKA 3 will cause the CORRECTION MODE of operation to be entered. The program will stop at a NUMERIC KEYBOARD instruction. At this point, enter the memory size for which the object program is being assembled. Depress any OCK. The program will then stop at a NUMERIC KEYBOARD instructions with three (3) PK's enabled. At this point, the source tape must be loaded in the A 581 Tape Reader and the A 562 Tape Perforator must be on. The enabled PK's determine the following functions:

PKA 5	ADD TO
PKA 6	CHANGE
PKA 7	DELETE

Add to Sequence Number – PKA 5

At the numeric keyboard entry which is reached via PKA 3, prior to depressing PKA 5, index the sequence number of the symbolic entry, from Phase I documentation, that precedes the area in which instructions are to be added. "ADD TO" will print followed by the sequence number.

The program will automatically read the source tape, punch out a new tape, and will build a label table in memory. When the sequence number indexed has been read and punched, the program will print the sequence number plus .1 (XX.1). This provides the ability to add one symbolic instruction in the position following the sequence number indexed (XX) with a sequence number of XX.1. Following the entry of this added symbolic operation, the program will return to the Correction Mode. To successively add a group of instructions, PKA 5 must be depressed prior to each added instruction. Re-entry of the sequence number isn't required. The added instruction will be automatically inserted and numbered in .1 increment. The number of "ADD TO" instructions is not limited, but when .9 is exceeded, duplicate sequence numbering will result.

Example:

If instruction sequence number 23 is incremented by ten .1 increments, the result would be a duplicate sequence number 24.0. Further "ADD TO" instructions would cause this sequence number to in turn be incremented (24.1, 24.2, etc.). The original instruction listed as 24.0 will appear in the output tape immediately following the last instruction added.

Re-entry of the original instruction is not required, however, duplicate sequence numbering can lead to difficulty in later correction of the source program; therefore, the original 24.0 sequence number should be "deleted" then a new sequence number "added." See Delete From Source Tape paragraph.

Change Source Tape – PKA 6

At the numeric entry reached by depressing PKA 3, prior to the depression of PKA 6, index the sequence number from the Phase I documentation that is to be changed. When the instruction is terminated by PKA 6, "CHG" will print followed by the number indexed.

The program will automatically read the source tape, punch out a new tape and will build a label table in memory. When the sequence number indexed has been read, it will not be punched out. The program will enter the Keyboard Correction Mode to permit entry of a line of coding following the entry of the changed symbolic operation, the program will return to the Correction Mode described under correction mode.

The assembler program permits instructions to be changed and new instructions immediately added to the program.

Depression of PKA 6 without a sequence number being indexed, will cause the very next instruction on the source tape to be read in but not punched out. If this is not the sequence number that was to be changed, the instruction would have to be entered via the keyboard.

Delete From Source Tape – PKA 7

At the numeric entry reached by the use of PKA 3, prior to the depression of PKA 7, index the sequence number, from the Phase I documentation that is to be deleted. When the instruction is terminated by the use of the PKA 7, "DEL" will print followed by number indexed. The program will automatically read the source tape, punch out a new tape and will build a label table in memory. When the sequence number indexed has been read, it will be ignored and not punched. Once deleted on first correction pass, that sequence number is gone and will never be found on any subsequent correction pass. The Assembler permits instruction deletion immediately followed by the addition of a new instruction. The program will return to the Correction Mode described under correction mode.

Depression of PKA 7 without a sequence number being indexed, will delete the next sequence in the tape and print out the sequence number deleted. This would of course result in an incorrect object program since an instruction was deleted that should not have been deleted.

Source Tape Interrupt Procedures

After indexing a sequence number and depressing any of the PK's described above, if the operator realizes that the wrong sequence number was entered, PKA 8 may be depressed. At the end of the line, the program will print out, "NOW AT" followed by the last sequence number read in and the program will stop at the Keyboard entry with the three (3) PK's enabled.

End Procedure

When the last "ADD TO," "CHANGE" and "DELETE" has been entered, the entry of any sequence number larger than the END sequence number, from Phase I documentation, will read the source tape and punch a new one. When the word END is read, it will cause termination of the Phase I correction routine and will then follow the END pseudo instruction procedure.

PHASE I – CONDENSED OPERATING INSTRUCTIONS AND REFERENCE LIST

1. Turn on tape perforator.
2. Be in READY MODE.
3. Depress PKA 2 (Load).
4. Depress MEMORY LOAD switch.

5. Read Phase I tape in PROGRAM LOADER.
6. After tape is read in, depress MEMORY LOAD switch.
7. Depress RESET key to return to READY MODE.
8. Depress PKA 1.
9. Depress PKA 2 for Keyboard Mode.
10. Type total words of memory you intend to use.
11. Depress any OCK and it will space correctly and stop for you to type the Op code of the first instruction. (Col. 22-26 on coding forms.)
12. Type OP Code.
13. Use one of the following 3 lists of instructions:
    a. No remarks (Col. 53)
       No label (Col. 16)
       (1) Depress OCK 1 or 3.
       (2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 1 or 3 after each parameter entry.
       (3) The final OCK will space for next Op Code entry.
    b. No label (Col. 16)
       Remarks present (Col. 53)
       (1) Depress OCK 4.
       (2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 1, 2 or 4 after each parameter entry.
       (3) Final OCK will space to remarks field. Type remarks.
       Depress OCK 1 to space to next OP code entry.
    c. Label present (Col. 16)
       (1) Depress OCK 2.
       (2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 2 after each parameter entry.
       (3) Final OCK will space to label field. Type label.
       (4) If no remarks, depress OCK 1 to space to next Op code entry.
       (5) If remarks present, depress OCK 4. Type remarks. Depress OCK 1 to space to next Op code entry.

Typing Error

If mistake made, depress PKA 8 before an OCK. It will print ERROR and will stop in Op code field for re-entry of instruction.

Correction Mode

1. Turn on perforator and put Source Tape in reader.

2. Be in READY MODE.
3. Depress PK 1.
4. Depress PK 3.
5. Type memory size and OCK 1.

Add To

1. Type sequence number before area to be added.
2. Depress PKA 5.
3. Program will read source tape, punch new tape, build label tapes.
4. When indexed sequence number has been reached, .1 will be printed beside it.
5. Add new instruction as other original instruction.
6. If there are additional instructions, depress PKA 5 and type next instruction.

Changing Source Tape

1. Type number to be changed.
2. Depress PKA 6.
3. Sequence number will not be punched.
4. Enter new instructions as original instructions.

Delete from Source Tape

1. Type sequence number.
2. Depress PKA 7.

Sequence Number Typing Error

1. Depress PKA 8.
2. Depress PKA 5, 6 or 7 again.

To Terminate any Correction

1. Enter any sequence number larger than the END sequence number then depress PKA 5, 6 or 7.
2. It will read source tape and punch a new one. This will give new symbolic tape and new label table.

PHASE I – DIAGNOSTIC FACILITIES

Provision is made for the detection and printed indication of errors that may occur in the Assembler program.

Error Detection and Indication

The entry of the symbolic language in Phase I, as previously stated, is via the keyboard or paper tape reader. Errors are detected as the symbolic entry is made.

MNEMONIC ERROR DETECTION – The mnemonic is entered first in sequence. If the mnemonic is invalid, the OCK used to terminate the entry will initiate an error sequence that will space the print head to position 10, print ERROR, align the form 1 space, and re-position the print head so that the invalid mnemonic may be corrected.

LABEL ERROR DETECTION – The next sequential operation, in the entry sequence of the program, is the entry of a label if required. The label error detection consists of determining if the label has been used previously and/or if the total number of labels exceeds the maximum of 139.

Duplicate label validation occurs after the specific symbolic operation has been entered. If the label is invalid, the print head is positioned to 10, ERROR is printed, and the printer document is aligned 1 space and a corrected entry must be made.

If the maximum of 139 labels is exceeded, the printer document advances to the next form (over fold), prints and punches out the contents of the label table up to that point. The assembler program will return the system to the ready mode and the correction routine must be used.

PARAMETER ERROR DETECTION – The parameters are also validated following the termination of their entry. Label-type parameters are not validated in Phase I. Separate error detection is used for numeric parameters and alpha parameters.

NUMERIC PARAMETER ERROR DETECTION – Two numeric parameter conditions are validated in Phase I.

1. Parameter exceeds specified limits (maximum or minimum) value.
2. Parameter is required and has not been entered.

In both cases, the validation routine will, upon recognizing the invalid condition, re-initiate the parameter entry sequence. However, if a zero parameter is acceptable, it is not necessary to index a zero. Leaving the parameter area blank will force the zero entry.

ALPHA PARAMETER ERROR DETECTION – An alpha parameter error is detected upon termination of the entry. In an invalid situation, such as entering an invalid alpha character, or no entry where an alpha entry is required, the print head will be positioned to 10, ERROR is printed, the printer document aligned 1 space and the entire symbolic operation sequence must be re-entered.

MEMORY ERROR DETECTION – Memory error conditions are:

1. The program exceeds the maximum memory available.
2. A specific point in the program is reached where sufficient memory has been occupied such that specifying a REG instruction, with a large parameter, will exceed the maximum memory available.

   In both of the above error conditions, the assembler program will return the system to the Ready Mode. This condition can only be corrected by use of the correction routine. (See correction mode.)

Error Detection – Correction Mode

The correction mode features error detection similar to that previously discussed.

MNEMONIC ERROR – If an invalid mnemonic is encountered, the validation routine will print the sequence number, label – if any – and the mnemonic as it appears in the input tape, align the form 1 space, print INSTR ERROR, punch a NOP instruction in the output tape and continue assembly.

LABEL ERROR – If an invalid label is encountered, the validation routine prints the sequence number, label and instruction as it appears on the input tape, aligns the form 1 space, prints LABEL ERROR, removes the invalid label, but punches the rest of the instruction in the output tape and continues assembly.

PARAMETER ERROR – If an invalid ALPHA parameter is encountered, (PK, LOD's, SK's or MASKS) the validation routine prints the sequence number, label, instruction and parameters, aligns the form 1 space, prints PARMTR ERROR, punches the instruction in the output tape and continues assembly.

PHASE I – OUTPUT

The output of Phase I of Assembler I consists of a print-out and a punched paper tape (source tape).

PHASE I – PRINT-OUT

The Phase I Print-Out is in the same format as the Phase I output tape. It is in two sections, the first is a listing of the Symbolic operations and the second a listing of the label table with memory addresses, as illustrated in Exhibit I.

PHASE I – OUTPUT TAPE

The output tape is created in two sections. The first section is the symbolic operation codes, complete with parameters and remarks, with the addition of a sequence number and the decimal equivalent of the actual location of the instruction in memory, punched in USASCII.

The format is:

Sequence Number

Decimal equivalent of the actual memory location of the operation.

Label (if entry is labeled)

Symbolic Operation Code

Parameters

Remarks

The second section of output tape is separated from the first section by approximately ten inches of unpunched tape. This is the label table and is punched in compact format hexadecimal which is the same format punched for the object program.

The format is:

Label

Memory Location

```
 1            NOTE                                    ADDING MACHINE EXAMPLE
 2            BRU      START                          BYPASS PSEUDO INSTRCT
 3            ORG      10
 4    TOTAL   NUM      0                              INITIALIZE AT ZERO
 5    STAR    ALF      ***                            SYMBOL FOR TOTAL
 6    START   LPNR     PRINT                          LOAD PRINT MASK AREA
 7            LPKR     KEYS                           LOAD PROGRAM KEYS
 8    ZERO    CLM      TOTAL                          CLEAR MEMORY TOTAL
 9    ENTER   AL       1                              ADVANCE FORM A LINE
10            POS      10                             POSITION TO PRINTER
11            PKA      12                             ENABLE PROGRAM KEYS
12            NKRCM    15              0              INDEX OPERANDS
13            PNS-     14              0              PRINT OPERAND
14            SK       K               2    2         USE OCK2 IF ERROR
15            ADM      TOTAL                          ADD TO TOTAL
16            EX       K               2    2         PRINT # FOR ERROR AMT
17            POS      30                             POSITION TO PRINT
18            PC       #                              PRINT CHARACTER
19            BRU      ENTER                          RETURN TO INDEX OPERAND
20    PRINT   MASK     ZZZZZZZZZZZ.DD                 PRINT FORMAT
21            WORD
22    KEYS    BRU      PRTSUB                         PKA1 TO SUBTOTAL
23            BRU      PRTTOT                         PKA2 TO TOTAL
24    PRTSUB  SRJ      COMR
25            PC       *                              TO SIGNIFY SUBTOTAL
26            BRU      ENTER
27    PRTTOT  SRJ      COMR
28            PA       STAR                           TO SIGNIFY TOTAL
29            BRU      ZERO                           GO TO CLEAR TOTAL
30    COMR    TRA      TOTAL                          COMMON TOTAL ROUTINE
31            PNS-     14              0              PRINT TOTAL
32            POS      30
33            SRR      1                              SUBROUTINE RETURN
34            END
```

Exhibit 1

Basic Assembler I

Phase I

PHASE II

Phase II of Assembler I uses a symbolic (source) paper tape as input and provides an object program tape which operates on a Series L/TC computer. It also provides a program listing with the object code as well as the symbolic code for each instruction and the absolute memory assignment. Phase II is also equipped with diagnostic facilities for the detection and indication of Phase II errors.

PHASE II – INPUT

The input to Phase II of the assembler program is the label-table tape, which has been separated from the symbolic tape and loaded via the program loader and the symbolic operation tape (source tape) which is mounted on the optional A 581 paper tape reader and entered under assembler program control.

PHASE II – OPERATING INSTRUCTIONS

The Phase II Assembler program must first be loaded into memory using the standard program load procedure. In addition, the same type of continuous pin feed forms must be used, with the forms positioned with left edge at position 5. If Phase II is being run immediately after running Phase I, it is not necessary to load the LABEL TABLE into memory. If Phase II is being run at any other time, it will be necessary to load the LABEL TABLE. This table is at the end of the source tape which is the output from Phase I. The table is separated from the source tape (sprocket holes only), is punched in compact hexadecimal format and must, therefore, be loaded via the program loader. When this procedure is complete, the RESET KEY must be depressed to return the machine to the READY MODE.

Start

PKA 1 – The program will stop at an Alpha Keyboard entry position to permit the typing of up to 6 alpha characters for any identification purposes desired.

At this point, the Symbolic output (source) tape from Phase I must be loaded on the A 581 tape reader and both the tape reader and tape punch switches turned on.

Depression of any OCK will cause the program to enter the automatic mode. This mode reads the source tape. Complete documentation is printed out, including the hexadecimal object program coding and all remarks. An object program will also be punched out.

The Assembler program Phase II will automatically put the machine into the READY MODE, when the Pseudo-Op END at the end of the source tape is read.

PKA 8 – This PK effects an interrupt. Operation can be resumed by the use of any OCK.

PHASE II – CONDENSED OPERATING INSTRUCTIONS AND INDEX

1. Turn on tape perforator.
2. Be in READY MODE.
3. Depress PKA 2 (Load).

4. Depress memory load switch.
5. Read Phase II tape in PROGRAM LOADER.
6. After tape is read in, depress MEMORY LOAD switch.
7. Depress RESET key to return to READY MODE.
8. At this point, if Phase I has not been run immediately prior to this, it will be necessary to load the label-table into memory using the same load procedure as in loading Phase II above. Then return to READY MODE.
9. Depress PKA 1.
10. Type up to 6 alpha characters for program identification and then OCK 1.
11. Insert symbolic tape into reader and depress READ switch.
12. This will give you a complete program listing and object tape.
13. If you have error in program it will be necessary to go to Phase I documentation for changes or to hexadecimally change program.

PHASE II – ERROR DETECTION AND INDICATION

As stated previously, the input to Phase II is the output tape, or source tape, from Phase I.

Error detection in Phase II is supplemental to the error detection in Phase I and is designed to validate the assignment of actual machine language, which is function of Phase II, plus the provision to indicate the possibility of machine-inflicted error, and the possibility of remote combination of programs vs. machine logic which could cause misinterpretation of the symbolic entries.

MNEMONIC ERROR DETECTION – The mnemonic is validated again in Phase II. At this particular point in assembler program progression, the potential error possibility is the misreading of the mnemonic as a result of a mispunch, some internal system failure or reader failure. In any event, an invalid mnemonic in Phase II is an irrecoverable error and will cause the validation sequence to return the system to the ready mode.

PARAMETER ERROR DETECTION – Parameters are again validated in the same manner as described under Phase I diagnostic facilities. In addition, if a label is used to define a parameter, the actual value of the label is validated.

For all parameter errors, except label errors, the word ERROR is printed starting in position 45, the printer escapes one space and PARMTR (parameter) is printed.

In the event of a parameter-label error, the word ERROR is printed starting in position 45, the printer escapes one space and LABEL IS printed.

For all instructions that are in error, a NOP instruction is substituted, printed out in the instruction sequence, and punched in the object program tape. The end result is that the object program tape contains NOP instructions instead of invalid instructions; plus, the program provides documentation which defines the location and type of parameter error.

```
33 0  C84D        133              PA      LINE                    77
   1  ED01        134              AL      1
   2  3849        135              TRA     TTL                     73
   3  EB76        136              POS     119

34 0  0700        137              RR
   1  C84F        138              PA      TOTAL                   79
   2  EB7E        139              POS     127
   3  D486        140              PN      8              6

35 0  804A        141              ADM     DWNTTL                  74
   1  D849        142              CLM     TTL                     73
   2  F740        143    LOOPT     PKB     7
   3  F640        144              PKA     7                               OVERFL
```

```
50 0  33366797    186              MASK    ZZD.DD
      03333333

51 0  66E66797    187              MASK    ZZZ.ZZD.DD
      03333333

52 0  33333679    188              MASK    ZD.D
      03333333

53 0  66E66797    189              MASK    ZZ,ZZZ,ZZD.DD
      0333336E

54 0              190    ORDRNO    REG     1
55 0              191    WDSAME    ALF     SAME*

56 0              192    WDPP      ALF     PP*

57 0              193    WDCOD     ALF     COD*

58 0              194    WDFGHT    ALF     MTFGHT*
```

Exhibit 2

Basic Assembler I

Phase II

Correction Routine Phase II

Phase II errors are corrected by using the Source tape (tape output from Phase I) and the Assembler Phase I correction routine, or correcting the Symbolic language and restarting the entire program. Corrections in the object program can be made by using the Memory Modify service routine with a corrected object tape generated with the Punch from Memory service routine. (See Section 3).

PHASE II – OUTPUT

The output from Phase II of Assembler I consists of a print-out and an object program tape.

PHASE II – PRINT-OUT

The Phase II print-out is a complete print-out of the object program along with explanatory information. The format is illustrated by Exhibit 2.

PHASE II – OUTPUT TAPE

The Assembler program Phase II output tape is the object program tape and is punched in compact hexadecimal format. It contains the complete program, in machine language, ready to be loaded directly into the Series L/TC computer.

ASSEMBLER II – 80-COLUMN CARD I/O – L/TC VERSION

Assembler II is a two pass version of the Series L/TC Assembler which operates on Series L/TC equipment with card I/O. Unlike Assembler I, Assembler II consists of only one program and is loaded only once. GP 300 symbolic punched cards are used as input, through the Card Reader. Pass I reads the symbolic deck, validates mnemonics, creates a label table, sequence checks the cards if requested, and prints certain errors. Pass II reads the symbolic deck again, produces a complete listing print-out including error messages and punches an object deck.

ENVIRONMENT

Series L/TC with full user memory

1 A 595 Card Reader

1 A 142 Keypunch

Assembler II Object Program, No. 1-1001-011-01
Firmware I.D. No. 2-1004-001-03

INPUT

Assembler II uses as input, GP 300 symbolic cards as defined in Section 1 and the desired control cards as described below.

CONTROL CARDS

The control cards specify the input and output of the Assembler II program. Each control card must contain a $ in card column one and the name of that control card starting in card column 16.

The control cards allowable are as follows:

$ DATA

This control card tells the system that the symbolic card deck is punched in EBCDIC code.

$ DATAB

This control card tells the system that the symbolic card deck is punched in BCL code. BCL code does not include some special characters available with EBCDIC.

$ SEQ-CK

This control card enables the checking of sequence numbers in the symbolic card deck. The sequence number of the current card is compared to the sequence number of the preceding card and if the value of the current card is less than or equal to the previous card, the error message SERR is printed and the program continues.

$ MEMORY

Firmware sets vary in memory requirements, which controls the amount of user memory available. If the size of object memory is other than 512 words, the Assembler II program may be informed by the

control option $ MEMORY followed by the memory size, stated as a 3-digit integer value, starting in card column 29.

$ PAGE51

This control card tells the system that the Assembler listing is being printed on a form 8½" x 11". If the above option is not used, the system assumes a form size of 11" x 14".

$ LABELS

This control card generates a list of labels along with the word and syllable location that each label represents. A maximum of 139 labels are allowed.

OPERATING INSTRUCTIONS

Readying the System

1. Unprotect (jumper) all tracks of main memory – words 0 to 1023 (do not jumper the utility track – Block 2 Track 2 – or any tracks that have been permanently jumpered by a Field Engineer.)
2. From the Ready Mode, load the Utility routine "Memory Load, Card Reader" I.D. No. 1-1001-054-00. Firmware I.D. No. 2-1004-001-03 must be in main memory before loading Assembler II.
3. Turn on Card Reader and depress Feed key. Place Assembler II object program deck in Card Reader and depress PKA 3 from the Ready Mode. After all cards have been loaded, depress any OCK or keyboard character to print the hash total, the system then returns to Ready Mode.
4. Preparation of Card Punch:
   a. Depress the POWER ON SWITCH and place blank cards in the feed hopper.
   b. Place a blank card around Program Drum No. 1. Around Program Drum No. 2 (left drum) place a card containing alternate "12" and "11" punches in card columns 1 through 80. These punches may start with either "12" or "11" so long as they alternate through all 80 columns.
   c. Place drums on the Card Punch and place brush assemblies in contact with drums, the Program Switch on the Card Punch keyboard may be set in any position.
   d. If it is desired to interpret the punch cards, the Print button should be depressed. Miscellaneous characters will be printed if the Card Punch is interpreting object program being punched.
   e. Depress the Auto Feed button to place a card in the punch station, depress the ERR. REL. key to position a blank card in the read station.
   f. Depress the Punch-On-Line button, the card punch is now under control of the Series L/TC. Halts on punch instruction if not on-line.

Pass I

Place control cards and symbolic deck in the Card Reader, depress PKA 1 from Ready Mode.

When it is necessary to temporarily halt assembly to add or remove cards in the Card Reader, three choices are available.

1. Depress Feed switch to OFF. To restart assembly, depress Feed switch to ON and depress Restart switch.
2. Depress RESET key, the program halts and the Numeric keyboard light is lit. Depression of any OCK will resume the assembly of the program.
3. The system halts on a Reader condition if there are no cards in the Reader and the last card read was not the END card. Placing cards in the Reader and depressing the Restart switch will cause the assembly to continue.

Pass I is completed when the symbolic END card is read. The system will halt on an NK instruction following the print-out of the label table, if a $ LABELS card was used.

Pass I Errors

During Pass I the only thing printed are the symbolic cards containing errors (card columns 11 through 77) preceded by a description of the error.

The following messages are used on the print-out to indicate detection of errors. These messages are printed in red.

Sequence Error

SERR – If the current card being checked at the request of the control card $ SEQ-CK has a lower or equal sequence number than the previous card, then that card is out of sequence.

Previously Used Label

LERR – The label in card columns 16 through 21 has been previously used. That instruction is not assigned a label, in Pass I or Pass II. The symbolic deck must be run again through Pass I, with a different label if the instruction is to have one.

Label Limit Exceeded

ELERR – A maximum of 139 labels are allowed, those labels beyond 139 are not put in the label table. The instruction is assembled without a label assigned to it.

Invalid Mnemonic

IERR – The mnemonic in the op code field is invalid. This card or a corrected card must be used in Pass II. It is assigned a syllable in memory.

Word Length Exceeded

No message is used when either the NUM or MASK instruction is too long to be translated into one word. The overflow is ignored and processing continues.

Memory Assignment Error

MERR – This tells the user that the specified memory has been previously assigned. This could occur for example if an ORG instruction is used and specifies a word number already assigned by the Assembler.

Assumed Memory

No message is used. Memory of 512 is assumed by the Assembler unless a $ MESSAGE specifies memory other than 512.

Memory Capacity Exceeded

MERR – This tells the user that the symbolic program is too large for the specified object memory size. The Assembler does continue to process.

End Card

No message is printed and the Assembler halts on a reader condition. The symbolic deck must have as its last card the mnemonic END card. To correct place END card in Reader and depress Restart key on Reader. Pass I cannot be completed without the END card.

Pass II

Place the control cards and all or part of the symbolic deck in the Card Reader and depress any OCK.

A complete listing print-out including error messages and an object deck is produced.

After Pass II is completed, it is necessary to reload main memory firmware before executing any assembled object program.

Pass II Errors

The description prints next to the field in error.

Undefined A Parameter Label

PERR – The label in the A parameter was never used as a label to a mnemonic instruction. A NOP is generated and Pass II continues.

Invalid Parameter Range

PERR – The value in the parameter is not within the limits allowed by the mnemonic. A NOP is generated and Pass II continues.

Invalid Increment Field

PERR – The value in the increment field is not within 255 or an invalid character is located within the field. A NOP is generated and Pass II is continued.

No Label or Increment Error

PERR – There is no label or the increment field is in error. A NOP is generated and Pass II is continued.

Invalid Mnemonic

IERR – The mnemonic is not in the language specifications. The mnemonic is ignored and a NOP is generated. Pass II is continued.

Word Length Exceeded

No message is used when either the NUM or MASK instruction is too long to be translated into one word. The overflow is ignored and processing continues.

Memory Capacity Exceeded

MERR – The symbolic program is too large for the specified object memory size. Pass II processing continues.

End Card

No message is printed and the Assembler halts on a Reader condition. Place END card in Card Reader and depress Restart switch. The symbolic deck must have as its last card the mnemonic END card. Pass II cannot be completed without the END card.

After the reading of all cards in Pass II, the last object program card is released. This completes Assembler II. The user may now reload main memory firmware, protect memory and run the object program just produced.

L/TC ASSEMBLER III B 3500 VERSION

The Assembler III Program operates on a B 3500 system and prepares an object program for Series L/TC systems. It accepts symbolic input directly from cards or will accept a symbolic punched paper tape if it is loaded on disk via a utility program prior to the execution of the assembler and the appropriate control card is included in the source media.

All references in this document to Assembler I or Basic Assembler I refer to the Series L/TC keyboard version of the Series L/TC Assembler.

ENVIRONMENT

The following system hardware is required for Assembler III:

B 3500 – 60 KB Bytes Core

1 Module Disk (800 segments, 100 bytes each)

1 Tape Unit (7 or 9 channel)

Card Reader

Paper Tape Punch

Paper Tape Reader (Optional for Symbolic Paper Tape Input)

Card Punch (Optional for Symbolic or Object Card Output)

Line Printer

LIBRARY TAPE INPUT

The input for Assembler III is the Group II Software Library Tape and the source media which is either a card deck that included both the symbolic program and the appropriate control cards, or the symbolic paper tape output from Phase I of the Basic Assembler I Program for Series L/TC systems.

Library Tape

The tapes contain the following programs:

ASSEMB	This is the assembler program.
QCONV	This produces the object program on paper tape.
LCNVRS	This converts input symbolic paper tape code to card image and stores it on disk. This must be executed first if symbolic tape input is specified. It creates a disk file which is used as the source file for input to the ASSEMB program.
CRDCVR	This produces a symbolic paper tape for input to Assembler I.
XREF	This is the cross-reference program. It produces a cross-reference listing of labels.
OBJCRD	This produces the object punched card deck.
LIBTAP	This is the maintenance program for the Library Tape created by the Assembler.

The following files are used internally in the Assembler III Program:

COND	Used in error detection.
OPTBL	The operation code file.

MCP CONTROL CARDS

The following MCP Control Cards are used in the assembly process; the 1-2-3 indicates a multi-punch in card column 1 for the specified cards:

Execute Card

The execute card initiates program execution. It must be punched in the following format:

```
1
2 EXECUTE ASSEMB
3
```

Data Card

The data card specifies the type source media. It must be punched in the following format:

```
1                                    1
2 DATA SOURCE          or            2 DATAB SOURCE
3                                    3
```

This tells the system that the source media is cards, punched in either EBCDIC or BCL code, respectively. BCL does not include some special characters available with EBCDIC.

Dollar Sign Card

The dollar sign card specifies an option which controls the input and output during the assembly process. It must be punched in the following format:

```
$       (LIST OPTION HERE)
```

The options available on Assembler III are discussed below.

Data Deck

The symbolic deck to be assembled.

End Card

The end card must follow any card deck. It is punched in the following format:

```
1
2       END
3
```

It tells the system that the input from the Card Reader is complete. This card is used in addition to the GP 300 END card.

OPTION CONTROL CARDS

There are several options which control the input and output of the Assembler III Program. The options,

specified in the succeeding sections, must be preceded by a ($) dollar sign and may either be coded on individual cards, or may be coded free-form serially on one or more cards.

SEQ-CK, Sequence Checking

The format on the control card is SEQ-CK. When a sequence number has been punched into column 11 through 15 of the source cards, sequence checking may be desired. If this control option is used, the sequence number of the current card is compared to the sequence number of the preceding card and, if the value is less or equal to, the error comment "SEQUENCE ERROR" will print. Execution of the program continues. Code generation is not ensured when sequence errors occur.

RESEQ, Resequencing

The format of the control card is RESEQ. If this control option is used, any sequence numbers punched in columns 11 through 15 of the source cards are ignored. Resequencing is initialized at 10 and incremented by 10 for each succeeding card.

MEMORY, Memory Size

Since different firmware sets vary in memory requirements, the size of user memory also varies. If the size of user memory is other than 512 words, the Assembler III Program may be informed by the control option MEMORY followed by the memory size, stated as an integer value. If this option is omitted, memory of 512 words is assumed and appropriate warning message is printed.

SYM-CD, Symbolic Card Output

If output, in symbolic BCL code, is required on punched cards, the symbolic-card control option SYM-CD is used. This will provide a symbolic card source deck, resequenced if the RESEQ option is used. If a program identification is punched in card columns 5-10 of the first symbolic card, it will be punched in every card of the output symbolic deck.

SYM-CN, Symbolic Card Output

This option is the same as SYM-CD with the exception that the output symbolic deck is punched in EBCDIC code.

SYM-PT, Symbolic Paper Tape Output

If symbolic paper tape output is required, the SYM-PT control option is used. This provides an input symbolic paper tape for Phase I of the Basic Assembler I Program.

LABELS, Printed Table of Labels

The entry of the control option LABELS provides a print-out of Assembler III generated table of labels. The list of labels is printed in the order in which they were programmatically defined along with the location that each label represents.

DOC, Documentation Punch and Print

If the psuedo-op DOC is used in a program and it is necessary to reproduce it in a symbolic card, the

control option DOC is used. $ DOC will retain the psuedo-op and print and punch it in its proper programmatic sequence.

PUNCH, Paper Tape Object Code

If the output of the Assembler III Program must be a Series L/TC object program punched in paper tape, the control option PUNCH is used. (See Section 6, Page 6-6 for a discussion of the object tape format.)

OBJ-CD, Object Card Output

If object card output in hexadecimal object code is required on punched cards, the control option OBJ-CD is used. This will provide an object card deck for input to a Series L/TC card system. (See Section 6, Page 6-2 for a discussion of the object card format.)

DISK-IN, Paper Tape Input

If the symbolic paper tape output from Phase I of the Basic Assembler I Program is to be used as input to the Assembler III Program, it is required that the conversion program, LCNVRS be executed prior to the execution of the Assembler III Program (discussed on Page 5-27. It also requires the control option DISK-IN which must be entered as the last control option in the control option deck. The DISK-IN card must be followed by an end card: ? END.

The Assembler III Program will use the information transferred from the symbolic paper tape to the disk by the conversion program, as source media.

XREF, Cross Reference of Labels

If a cross reference listing of labels is desired, control option XREF is used. The labels are printed in alphabetical order with their sequence number and the sequence numbers of those statements referencing that label.

LINES, Specifying Number of Lines Per Page

This option will permit the programmer to specify the number of lines desired on each page below the heading. It is possible to use any two-digit integer for the number of lines per page. If this option is not used, the maximum of 60 is assumed, which provides 7½ inches of text at 8 lines per inch.

SAVE XXXXXX

This will cause the Assembler to retain the object program upon the disk. Punching of paper tape or 80-column card does not occur. XXXXXX represents a 6 alpha character disk file-name. It must be used in conjunction with $ PUNCH or $ OBJCD.

OPERATING INSTRUCTIONS

Operation of the Assembler III Program involves the setting up of peripherals as a major function as opposed to Basic Assembler I Program operation which requires manual intervention as a major function.

Equipment Setup

To exercise all the control options of the program, 1 magnetic tape unit, 1 card reader, 1 card punch, 1 paper tape reader, 1 paper tape punch, and a line printer are required.

1. Magnetic Tape Units

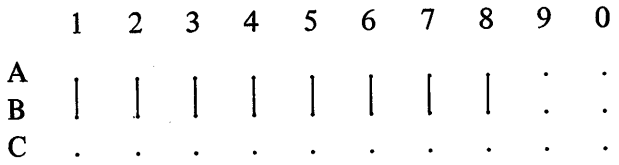
   Mount the Library Tape. Choose an MTU with the proper channel (7 or 9) and set the appropriate density. Both of these are marked on the library tape reel label. Load the tape reel.

2. Card Punch (If symbolic or object card-out is required)

   Load the hopper on the card punch with sufficient cards and ready the punch.

3. Paper Tape Reader (If symbolic paper tape-in is desired)

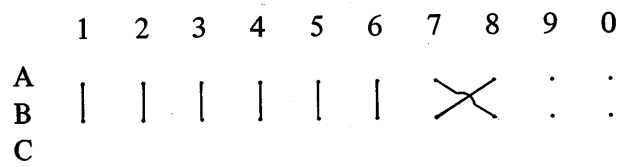
   Wire the channel select board, inside the front doors on the upper left of the reader in the following manner.



   Turn the three control code switches off. Depress the Parity on-off switch to off. Depress the High-low switch to low. Depress the Strip-Reel switch to strip or reel, depending on input type.

4. Paper Tape Punch

   Wire the channel select board, inside the front doors on the upper left of the punch, in the following manner:



   Turn the Control Code Switch off. Set the LEVEL Designator Switch to 8-LEVEL. Ready the punch.

5. Line Printer

   Equip the printer with an 8 lines per inch control tape and ready the printer.

Operation

Loading the Library Tape: The loading of the magnetic library tape may be initiated by either a control card or a control input message via the supervisory printer (SPO). If a control card is used, the card would read

```
1
2 LOAD FROM GRPII < list of programs and files to be loaded >
3
```

The control card would load the programs specified from the list of available programs and files. For example:

```
1
2 LOAD FROM GRPII ASSEMB QCONV CRDCVR OPTBL COND OBJCD XREF
3
```

In either case the card must be passed through the card reader by itself. When the tape has been loaded, an output message to this effect will be typed on the SPO, after which the Assembler may be executed.

If the library tape load is initiated via the SPO, the input message

CC LOAD FROM GRPII < list of programs and files to be loaded >

would load only the specified programs and files.

Assembling with Card Input: If symbolic punch card input is used, the following cards must be read in through the card reader in the order specified:

1.
```
1
2 EXECUTE ASSEMB
3
```

2.
```
1                       1
2 DATA SOURCE (or 2 DATAB SOURCE if BCL is used)
3                       3
```

3. $ Option Cards specifying any or all of the options defined.

4. The symbolic source deck.

5.
```
1
2 END
3
```

Assembling with Symbolic Paper Tape: If symbolic paper tape input is used, the paper tape must first be loaded via the paper tape reader, converted to card format, and placed on disk using the LCNVRS program (which must have previously been loaded). After mounting the symbolic tape on the paper tape reader, the following card must be read in through the card reader in the order specified:

```
1
2 EXECUTE LCNVRS
3
```

When the symbolic paper tape has been loaded, the procedure discussed above for punch card input would be followed with the exception that the DISK-IN option must be the last option specified and must be followed immediately by the END card (since no symbolic deck is used).

ERROR DETECTION

The Assembler III Program in processing the input, or source, data makes several passes through the information. These passes may be divided into 2 major categories:

1. Pass I – the processing of data prior to the assignment of object code to the symbolic program.
2. Pass II – the processing of the data, the major function of which is the assignment of object code.

Both passes incorporate editing functions and the resultant error detection.

Pass I Error Detection

Pass I errors are printed out prior to the program listing. Each error comment will be followed by the print-out of the symbolic operation which is determined to be in error.

LABEL ERRORS – Several types of label errors are detected in Pass I:

1. Duplicate Label

   If a label has been previously used, the error comment printed starts with the label followed by:

   . . . HAS ALREADY BEEN ENTERED AS A SYMBOLIC IDENTIFIER

   the duplicate label is not entered, processing continues.

2. Invalid Label

   Labels for the Assembler III Program must begin with an alphabetic character. If the first character of the label is not an alphabetic character, the error comment is:

   LABEL MUST BEGIN WITH AN ALPHABETIC CHARACTER

   Blanks are not allowed in a label. If the label contains a blank, the error message is:

   LABEL MUST NOT CONTAIN BLANK CHARACTER

   The label is not entered, processing continues.

3. Label Limit Exceeded

   The Assembler I Program allows a limit of 139 labels. This limit is not significant to the Assembler III Program, but the possibility exists that a symbolic paper tape, generated by the control option $ SYM-PT could be used as input to the Assembler I Program for Series L.

   The error comment is:

   NUMBER OF LABELS EXCEEDS LABEL LIMIT WHEN USING ASSEMBLER I

   The error is ignored and processing continues.

4. Card Field Definition Label Error

   Labeling of the CDF table is allowed only on the first syllable of a word. If the label is not on the first syllable of a word, the error message is:

   LABEL NOT AT START OF WORD

   A NOP is inserted and processing continues.

SEQUENCE ERROR – As described in Option Control Cards, if $ SEQ-CK is used, and the sequence

number in columns 11 through 15 of the current card is less than the sequence number on the previous card, the error comment is:

SEQUENCE ERROR

This is followed by a print-out of the information on the current card and processing continues.

EXCEEDS MEMORY CAPACITY – If the symbolic program is too large for the specified object memory size, or if an erroneous ORG instruction has been entered, the error comment is:

STORAGE EXCEEDED BY INSTRUCTION . . . .

followed by a print-out of the instruction that exceeded memory. Processing continues.

REGION ERROR – If a REG instruction is entered with either a 0 parameter or a parameter exceeding 255, the error message is:

REGION MUST HAVE SIZE 1-255

A memory location is not reserved and processing continues.

BACKWARD ORGANIZATION ERROR – If an ORG instruction is entered that attempts to assign memory that has been previously assigned, or at a memory location sequence number that is lower than the current instruction address, the error message is:

BACKWARD ORG NOT ALLOWED ON ASSEMBLER I

Memory is assigned and assembly continues.

CONTINUATION CARD ERROR – If a card with a numeric field length follows either an ALF or MASK instruction with a field length greater than 24, a continuation card was expected. The error message consists of a print-out of the current card followed by:

PREVIOUS CARD HAS INVALID FIELD LENGTH

In an ALF instruction a missing field length will result in the error message:

EMPTY FIELD-LENGTH FIELD

In either case the instruction assigns 1 word which is not filled and processing continues.

INVALID MASK ENTRY – If an invalid mask character has been entered, the character will be printed followed by:

. . . . IS NOT A VALID MASK ENTRY

the character is ignored and processing continues.

MASK LENGTH ERROR – If an erroneous mask length has been specified, the mask will be printed followed by:

MASK LENGTH RECALCULATED TO BE . . .

and the correct length. The mask is corrected and processing continues.

INVALID OPERATION CODE – If an invalid op code is entered, the invalid code will be printed followed by:

. . . IS AN INVALID INSTRUCTION OP CODE

A NOP (no operation) instruction is generated and processing continues.

PARAMETER ERRORS – The parameter errors detected in Phase I are defined in the following sections.

1. No Label

   Some of the instructions specified in Series L Assembler Language, required a label in the parameter field. If a label has not been entered, the error message is:

   MISSING SYMBOLIC LABEL

   The instruction is ignored, a NOP is assembled and processing continues.

2. Increment Exceeds Limit

   If the increment exceeds the limit of 255, the error message:

   INCREMENT GREATER THAN 255 NOT ALLOWED ON ASSEMB I

   is printed.

   This does not affect Assembler III or IV, processing continues.

3. Invalid Numeric Entry

   If a non-numeric character is entered in the numeric portion of a NUM instruction, the error message is:

   INVALID NUM ENTRY

   A word of zeros is assembled and processing continues.

4. Parameter Length Exceeded

   If the parameter length of either a MASK or NUM instruction is too long to be translated into 1 word, the error message:

   PARAMETER TOO LONG

   is printed, a word of zeros is assembled and processing continues.

5. Invalid Define Parameters

   If the entry in the parameter field of a DEF is invalid, the error message is:

   A-ENTRY MUST BE NUMERIC AND LESS THAN 767

   If either one or both entries in the parameter fields of a DEFT are invalid, the error message is:

   DEFT PARAMETERS MUST BE NUMERIC AND 0-15

   In either case memory is not assigned and processing continues.

6. Code Parameter Error

   If entries in the CODE instruction parameter field are not 0 through 9 and A through F, the error message is:

   ILLEGAL DIGIT ENTERED IN CODE INSTRUCTION

   A NOP is inserted and processing continues.

7. Card Field Definition Error

   If the total length of the fields defined in the CDF instruction exceeds the maximum number

of characters allowed on a card, the error message is:

SUM OF CDF PARAMETERS MUST NOT BE > 80

A NOP is inserted and processing continues.

CARD BUFFER DECLARATION ERROR – A CDB instruction must be the first card in the symbolic source deck. If it is not the first card, the error message is:

CDB MUST BE FIRST INSTRUCTION IN DECK

The instruction is ignored and processing continues.

Pass II Error Detection

At the beginning of the second pass, the printer will skip to the starting position on the next page.

LABEL ERRORS – Label error detection includes the re-evaluation of the label limit and validation of labels in the parameter field.

1. Label Limit Exceeded

   This is identical to Pass I and uses the same error comments.

2. Label Parameter Error

   If the label entered as an A parameter has not been recorded as a label identifier, the error comment prints the label followed by:

   . . . HAS NOT BEEN ENTERED AS A LABEL

   A NOP is generated and processing continues.

3. Label Increment Error

   If a label is valid but the increment is invalid, the error message is:

   ILLEGAL ENTRY IN INCREMENT FIELD

   The increment is ignored and processing continues.

INVALID OPERATION – The validity of the operation code is rechecked in Pass II and if invalid, the entry is printed followed by:

. . . NOT A VALID OP-CODE

A NOP is generated and processing continues.

PARAMETER ERRORS – The parameters are edited for validity and content in Pass II.

1. Label Parameter Error

   See above.

2. No Parameter Entry

   If a required parameter has not been entered, the error comment will be:

   EMPTY

   followed by the specific field in which the error occurred, A PARAMETER, B PARAMETER or C PARAMETER. The program assumes a value of zero and processing continues.

3. Illegal Parameter Entry

   For a parameter entry in a field that should be empty the error comment is:

   ILLEGAL PARAMETER ENTRY IN . . .

   followed by; A PARAMETER, B PARAMETER or C PARAMETER, depending upon which parameter contained the error. Processing continues.

4. Invalid Parameter Entry

   For an entry that is invalid in either size or type, a listing of the valid parameter entries for that specific instruction is printed including an indication of which parameter(s) is/are in error.

   Example:

OP	A	B	C
ADIR	I	32	

   In the above instruction a keypunch error has been made in the A parameter field.

   The error message is:

A PARAMETER	–	MUST HAVE NUMERIC VALUE 1-4
B PARAMETER	–	MUST HAVE NUMERIC VALUE 0-255

   If a symbolic entry is allowed the error message is:

   SYMBOLIC ENTRY ALLOWED

5. Flag Instruction Parameter Error

   If the flag designated in the parameter is not valid for the flag group specified, the error message is:

   INVALID FLAG ENTRY PAIR OF

   The entry is ignored and processing continues.

OUTPUT

The output of the Assembler III Program may be any, or all, of the output options described under Control Options. In addition to the paper tape or card media produced as output, a print-out, which lists the symbolic input, object code developed, and any error comments is produced at the completion of the program. An example of a symbolic listing (with or without Control Options) is illustrated on the following page. The word and syllable of the instruction is listed along with sequence number, object code, expanded print-out of the source card, and decimal equivalent for each label used within a source statement.

If the control option PUNCH is used, a separate print-out of the object code will be produced. Similarly, a card listing is produced if the option OBJ-CD is used. Examples of these as well as the Label Table (LABELS option) and the Cross Reference Listing (XREF option) are provided.

WORD	SYL	OBJECT CODE	SEQ. NO.	SYM. LOC.	OP CODE	FD. LN.	A-PARAMETER LABEL	INC	B PAR	C PAR	LABEL DEC	LABEL EQU	REMARKS
6	0	5803	29 0		IIR	3		3					TEST FOR COMPLETION
	1	4184	30 0		SK	T		T	1				TERMINATE LOOP
	2	7C04	31 0		BRU	SHIPTO				4	3		REPEAT
	3	7809	32 0		BRU	RIBBON				9	2		JUMP TO RIBBON AREA
7	0	4184	33 0		SK	T		T	1				TERMINATE LOOP
	1	7C04	34 0		BRU	SHIPTO				4	3		REPEAT LOOP
	2	4599	35 0		EX	K		34	1				BRANCH TO PRINT SAME
	3	7C08	36 0		BRU		+ 4			8	3		EXIT LOOP
8	0	6744	37 0		SET	X		2					SET TO ENTER SHIPTO LOOP
	1	ED02	38 0		AL	2							ADVANCE TWO LINES
	2	7C04	39 0		BRU	SHIPTO				4	3		RETURN TO LOOP
	3	ED02	40 0		AL	2							ADVANCE TWO LINES
9	0	EB0C	41 0		POS	NMAD-P				13			
	1	C888	42 0		PA	SAME				136			PRINT ALPHA MESSAGE
	2	E914	43 0	RIBBON	ALTO	RIBBL				20			ADVANCE TO RIBBON LINE
	3	EB05	44 0		POS	TERM-P				6			POSITION TO TERMS

Notice in sequence number 420 the actual memory location being referenced by label SAME is 136.
In sequence number 390 the unconditional branch to SHIPTO is actually a branch to word 4 syllable 3.
In sequence number 410 the actual value associated with label NMAD-P is 13.

Labels Listing:

	LABEL	VALUE
1	INITAL	000 03
2	BEGINV	001 02
3	SHIPTO	004 03
4	RIBBON	009 02
5	BODYIV	013 01
6	MAX	015 00
7	TKDESC	020 02
8	MPRICE	022 01
9	GRSAMT	029 01

Illustration I

The value of a label refers to the word number associated with the label in defined memory (regions, numeric constants, etc.). Value refers to the word number and syllable number associated with the label in program memory. The list is in the order in which the labels were programmatically defined.

Labels Cross Reference Listing:

NE	PKA6	01620	01920		
NE	PKA7	00150			
NE	PKA8	00050			
0466.0	ACT	02980			
0192.0	ADDONS	01700	02260		
0369.0	ADLNCK	01740	01990		
0502.0	ADON-P	01660	01770	01930	02050

Illustration II

Associated with each label, listed alphabetically, is the sequence number of the instruction where the label was defined as well as the list of sequence numbers of instructions that reference the label.

L/TC ASSEMBLER IV B 5500 VERSION

The Assembler IV Program operates on a B 5500 system and prepares an object program for Series L/TC systems. It accepts symbolic input directly from cards and will accept a symbolic punched paper tape if the appropriate control card is included in the source media.

All references in this document to Assembler I or Basic Assembler I refer to the Series L/TC keyboard version of Assembler I.

ENVIRONMENT

The following system hardware is required for the TC 500, Basic Assembler Program:

B 5500 – 4 memory modules utilizing MCP
1 Module Disk (300 segments, 240 characters each)
1 Tape Unit (7 or 9 channel)
Line Printer
Card Reader
Paper Tape Punch
Paper Tape Reader (Optional for Symbolic Paper Tape Input)
Card Punch (Optional for Symbolic or Object Card Output)

MCP CONTROL CARDS

The following MCP Control Cards are used in the assembly process:

Execute Card

The execute card initiates program execution. It must be punched in the following format:

```
1
2 EXECUTE ASSEMB/TC500
3
```

Data Card

The data card specifies the source media. It must be punched in the following format:

```
1
2 DATA SOURCE (Only BCL card code is accepted.)
3
```

Library Tape Input

The input for Assembler IV is the library tape labeled "TC 500," and the source media which is either a card deck that includes both the symbolic program and the appropriate control cards, or the symbolic paper tape output from Phase I of the Basic Assembler I Program for Series L/TC systems.

Library Tape/TC500

The tapes contain the following programs:

ASSEMB/TC500	This is the assembler program.
XREF/B55TC	This is the cross-reference program. It produces a cross-reference listing of labels at the end of assembly.

The following files are used internally in the Assembler IV Program.

0000000/COND	Used in error detection.
0000000/OPTBL	The operation code file.

Dollar Sign Card

The dollar sign card specifies an option which controls the input and output during the assembly process. It must be punched in the following format:

```
$ (LIST OPTION HERE)
```

Data Deck

The symbolic deck to be assembled.

End Card

The end card must follow any card deck. It is punched in the following format:

```
1
2 END
3
```

It tells the system that the input from the Card Reader is complete.

OPTION CONTROL CARDS

The following options available with Assembler III (B 3500 version) are available with Assembler IV and function identically.

SEQ-CK, Sequence checking

RESEQ, Resequencing

MEMORY, Memory size

SYM-PT, Symbolic paper tape output

LABELS, Printed table of labels

DOC, Documentation – punch and print

XREF, Cross reference listing

LINES, Specifying number of lines per page

SYM-CD, Symbolic card output

The following options available with Assembler III function differently with Assembler IV.

PUNCH, Paper Tape Object Code

This option is different in that the object program is punched in ASCII code and must be converted to internal Series L/TC format. See Section 6, Page 6-3, for this conversion procedure.

OBJ-CD, Object Code Card Output

This option is different in that the object program is punched in BCL and must be converted to internal Series L/TC format. See Section 6, Page 6-3, for this conversion procedure.

The option PT-IN is used with Assembler IV in a manner identical to that of DISK-IN with Assembler III. That is, PT-IN is used for symbolic paper tape input.

The option SYM-CN, available with Assembler III, is not available on Assembler IV.

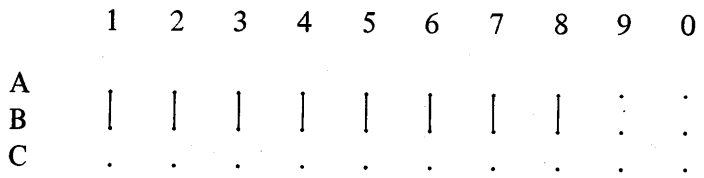
OPERATING INSTRUCTIONS

Operation of the Assembler IV Program is identical to that of Assembler III (B 3500 version) with the following exceptions.

Equipment Setup

The only differences in equipment setup are found with the paper tape reader and paper tape punch. The setup procedure for each is therefore given here.

PAPER TAPE READER – (If symbolic paper tape-in is desired.) The Paper Tape Reader must have an Input Code Translator Board, wired as illustrated in Figure 5-2. (Wire 1 for 1: A-1 to A-1, B-1 to B-1, etc.) Wire the channel select board, inside the front doors on the upper left of the reader in the following manner:



Turn the three control code switches off. Depress the Parity on-off switch to Off. Depress the High-Low switch to Low. Depress the Strip-Reel switch to Reel.

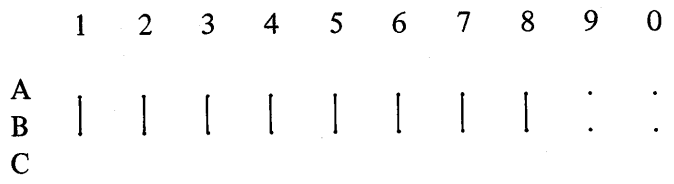
The input paper tape must have an opaque strip approximately 1½" long attached at a minimum of 2½' prior to the first data frame and 2½' after the last frame.

Depress Load Switch. Position tape under the Read Head to the frame preceding the first data frame.

Depress Ready Switch then set Remote/Local Switch to Remote. When the first paper tape read instruction is encountered, the Supervisory Printer will respond with an "unlabeled paper tape file" message. The operator must respond with the appropriate corrective procedure.

PAPER TAPE PUNCH – The Paper Tape Punch must have an Output Code Translator Board, wired as

illustrated in Figure 5-1. (Wire 1 for 1: A-1 to A-1, B-1 to B-1, etc.) Wire the channel select board, inside the front doors on the upper left of the punch, in the following manner:



Turn the Control Code Switch off. Set the LEVEL Designator Switch to 8-LEVEL.

OPERATION

There are a few differences between Assembler IV and Assembler III with respect to the operation of the system. These differences are as follows.

Loading the Library Tape: The SPO message which loads the magnetic library tape is:

```
CC LOAD FROM TC500 =/=.
```

If the tape is loaded by card, the necessary control card would be:

```
1
2 LOAD FROM TC500 =/=.
3
```

Assembling with Card Input: The first card in the deck must be:

```
1
2 EXECUTE ASSEMB/TC500.
3
```

The rest of this procedure is identical to that of Assembler III.

Assembling with Card Input: The option card PT-IN with an Assembler IV replaces the option card DISK-IN of Assembler III. The rest of this operation is the same.

ERROR DETECTION

The editing functions and error messages provided by Assembler IV are identical to Assembler III (B 3500 version).

OUTPUT

The output from Assembler IV is the same as that from Assembler III with a few exceptions.

1. With Assembler IV, no card listing is provided with object card output (OBJ-CD option).
2. The object paper tape output code with Assembler IV is USASCII rather than the compact hexadecimal provided by Assembler III. Thus, the object code provided by Assembler IV must be converted to compact hexadecimal in order to operate on a Series L/TC System. See Section 6 for this procedure.
3. Object card from Assembler IV is punched in BCL as opposed to compact hexadecimal output from Assembler III. Thus, an output program deck from Assembler IV must be converted prior to attempting to operate on an L/TC System. See Section 6 for this operation.

L/TC ASSEMBLER V – B 300 VERSION

The Assembler V program operates on a B 300 system and prepares an object program for Series L/TC Systems. The program accepts symbolic input directly from cards and will accept a symbolic punched paper tape if the appropriate control card is included in the source media.

ENVIRONMENT

The following system hardware is used for Assembler V.
B 283 or equivalent having a minimum 9.6K core memory configuration.

- 3 – Tape Storage Units
- Line Printer
- Card Reader
- Card Punch
- Paper Tape Reader (optional)
- Paper Tape Punch (optional)

A Central Processor with punch binary capability is required if object cards in Series L internal code are required.

INPUT

The input for Assembler V is the Assembler V Program object deck and the source media which is either a card deck that includes both the symbolic program and the appropriate control cards, or the symbolic paper tape output from Phase I of Assembler I with appropriate control cards. Symbolic cards are punched as defined in Section 1.

OUTPUT

The output of the Assembler V Program may be any one of the output object options and/or any one of the output symbolics described under control cards.

CONTROL CARDS

Data Cards formulate the option control deck and specify the options which control the input and output of the Assembler V Program. Each card is punched with a ($) sign in card column 1 and the option information coded starting in column 16.

The control cards allowable are:

$ Date

This control card is used to express the date. Ten (10) characters are reserved starting in column 29.

$ I/P Card

This control card is used to tell the system that the source media is cards punched in BCL code.

$ PT-IN

This control card is used if the symbolic paper tape output from Phase I of the Assembler I Program is used as input to the Assembler V Program.

$ SEQ-CK

This control enables sequence checking of the sequence number punched in card columns 11 through 15.

$ RESEQ

When this control card is used, any sequence numbers punched in columns 11 through 15 of the source cards are ignored. Resequencing is initialized at 10 and incremented by 10 for each succeeding card. If both sequence checking and resequencing are specified, sequence checking will be ignored.

$ MEMORY

If the size of the object memory is other than 512 words, the desired size may be inserted by the option $ MEMORY followed by the memory size stated as a 3-digit integer value, starting in card column 29.

$ SYM-CD

This option provides a symbolic card source deck, resequenced when the $ RESEQ control option is used.

$ SYM-PT

This option provides an input symbolic paper tape for Phase I of Assembler I.

$ OBJCD

This control option is used when the output of the Assembler V Program is to be an object program on punched cards in 80-column card compact hexadecimal format.

$ O/P OBJECT CARD BCL

This control option is used when the output of the Assembler V Program is to be an object program on punched cards in BCL format.

$ PUNCH

This control option is used when the output of the Assembler V Program is to be an object program in punched paper tape, USASCII format.

$ LABELS

The entry of this control option provides a print-out of the label table generated by the Assembler V Program. The list of labels is printed in the order in which they were programmatically defined, along with the location, or value, that each label represents.

END

The system is informed that the input from the Card Reader is complete by use of the mnemonic END card included at the end of the source deck; or by actuation of the END OF FILE button on the Reader.

OPERATING INSTRUCTIONS

Operation of the Assembler V Program involves the setting up of peripherals as a major function as opposed to Assembler I which requires manual intervention as a major function.

Equipment Setup

1. Magnetic tape units

   Set the 3 magnetic tape units, designated as stations 1, 2, 3, for remote operation. Make sure that all other magnetic tape units, set for remote operation, are addressed by station numbers other than 1, 2 or 3.

2. Line Printer

   Equip the printer with a 6 lines per inch control tape and press the READY button.

3. Card Reader

   See Operation.

   Paper Tape Reader (if required).

   The paper tape reader uses an Input Code Translator Board wired as illustrated in Figure 1. Wire 1 for 1: A-1 to A-1, B-1 to B-1, etc.

   The Channel Select Plugboard is wired one to one:

	1	2	3	4	5	6	7	8	9	0
A	⌀	⌀	⌀	⌀	⌀	⌀	⌀	⌀	0	0
B	⌀	⌀	⌀	⌀	⌀	⌀	⌀	⌀	0	0
C										

4. Card Punch (if required).

   Load the hopper of the card punch with sufficient cards and press the READY button.

5. Paper Tape Punch (if required).

   The paper tape punch uses an Output Code Translator Board wired as illustrated in Figure 2. Wire 1 for 1: A-1 to A-1, B-1 to B-1, etc.

   The Channel Select Plugboard, inside the front doors on the upper left of the punch, is wired in the following manner:

	1	2	3	4	5	6	7	8	9	0
A	⌀	⌀	⌀	⌀	⌀	⌀	⌀	⌀	0	0
B	⌀	⌀	⌀	⌀	⌀	⌀	⌀	⌀	0	0
C										

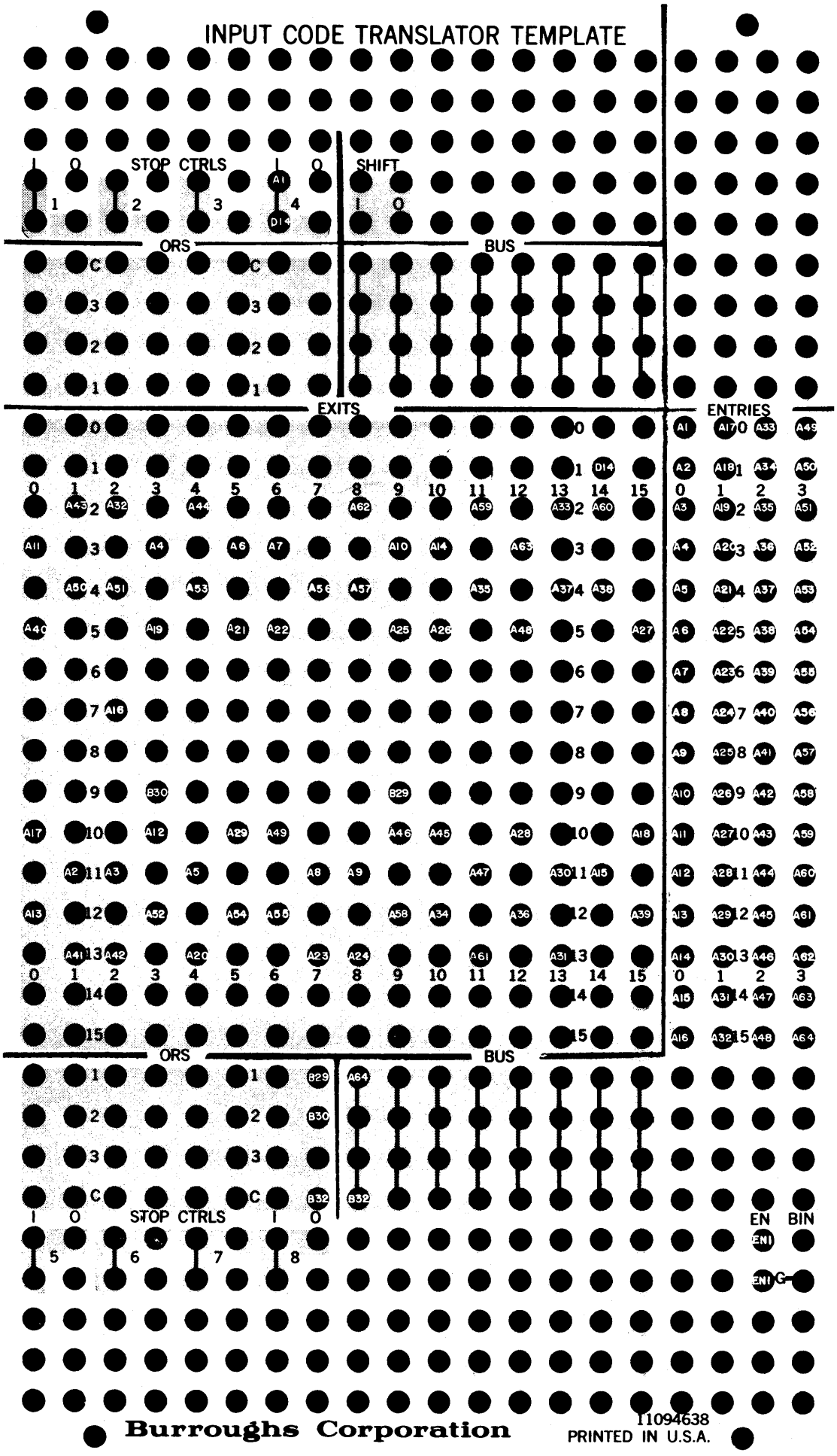

INPUT CODE TRANSLATOR TEMPLATE
STOP CTRLS
SHIFT
ORS
BUS
EXITS
ENTRIES
ORS
BUS
STOP CTRLS
EN
BIN
Burroughs Corporation
11094638
PRINTED IN U.S.A.

FIGURE 1

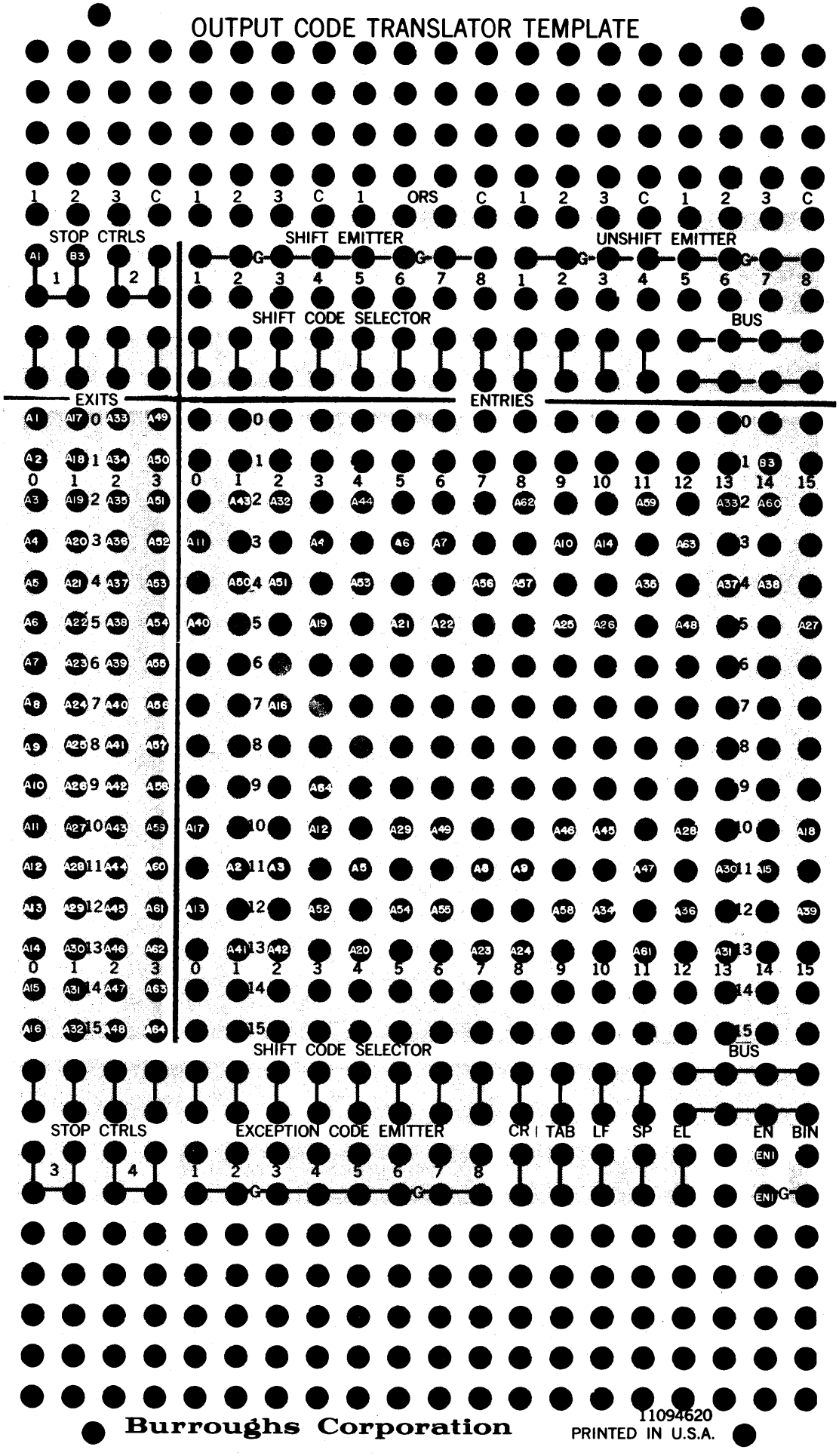

OUTPUT CODE TRANSLATOR TEMPLATE
1 2 3 C 1 2 3 C 1 ORS C 1 2 3 C 1 2 3 C
STOP CTRLS
SHIFT EMITTER
UNSHIFT EMITTER
SHIFT CODE SELECTOR
BUS
EXITS
ENTRIES
SHIFT CODE SELECTOR
BUS
STOP CTRLS
EXCEPTION CODE EMITTER
CR TAB LF SP EL EN BIN
Burroughs Corporation
11094620
PRINTED IN U.S.A.

FIGURE 2

Turn the Stop and Delete Switch Off.

Set the Level Switch to 8-Level.

Operation

After the peripherals are set up as described above, proceed with the following operations:

1. Press the CLEAR Switch on the console of the Central Processor.
2. Load the first 160 cards of the Assembler V object deck into the card reader hopper and press the RESET and START switches on the card reader.
3. Press the LOAD switch on the processor and the object cards will begin to read in.
4. After the 160 cards have been read, press the processor CLEAR switch.
5. Place the remainder of the object deck, the control cards and the GP 300 source deck, when used, in the card reader hopper and press the RESET and START switches on the card reader.
6. Press the processor CONTINUE switch and the card reader will read the remaining cards.

NOTE: If the source deck does not end with a GP 300 END pseudo card, press the END OF FILE switch on the card reader after the card reader has read the last card.

7. When the paper tape is used in place of the source deck, the control card deck should be concluded with any card not having a $ in card column 1. The RESET, START and CONTINUE switches are then pressed to read the remainder of the object deck and control cards.

NOTE: If the control deck of cards is not concluded with a card not having a $ in card column 1, the END OF FILE and START switches on the card reader must be pressed after the card reader has read the object deck and control cards.

Once the object deck and first control card have been read, the Assembler V Program can be reinitialized automatically by pressing the CLEAR, then CONTINUE switches on the processor console. This means the user can start over at any point of processing without reloading the object card deck.

Programed Halts

The Assembler performs a number of automatic edits of the input data. Programed halts inform the operator of conditions requiring immediate attention. The halt indicator on the central processor is illuminated and the digit 9 is displayed in the O position of the INSTRUCTION register. The M and N positions of the register identify the specific programed halt that is encountered. See table 1.

PROGRAMED HALTS

INSTRUCTION REGISTER O	M	N	CAUSE	REMEDY
9	2	0	Invalid control card	Correct the last card read, reinsert and press CONTINUE switch on the central processor.
9	2	2	End of magnetic tape	Rerun on a larger reel of tape.
9	2	4	No input control card entered	Insert card, press CONTINUE.
9	2	8	Paper Tape punch out of paper	Reload paper tape punch, press CONTINUE.
9	2	9	End of assembly	Press CONTINUE to start next assembly.
9	6	0	Paper tape read error	Press CONTINUE. If unable to read, space past the bad record and press CONTINUE again.
9	6	1	Paper tape reader out of paper	Reload paper tape reader, press CONTINUE.
9	6	4	Paper tape field greater than 26 characters. Tape or reader is in error.	Press CONTINUE to bypass the entry and resume the processing.
9	6	5	NUM on paper tape with wrong sign character. Tape or reader in error.	Press CONTINUE to bypass the sign and resume the processing.
9	7	0	Paper tape punch out of paper	Reload paper tape punch, press CONTINUE.
9	7	N	Magnetic tape read error. Station number is indicated by N.	Press CONTINUE. If unable to read, restart with new tape and reload the Assembler from cards.

Table 1

Error Detection

The Assembler V Program, in processing the input, or source data, makes three basic passes through the information.

Pass I accepts input from punched cards or punched paper tape, validates mnemonics and adds control information creating a resultant symbolic output on magnetic tape.

Pass II updates the output or source tape from Pass I, generating a new symbolic tape and creating a magnetic tape label table.

Pass III processes the outputs of Pass II assigning the object code to the symbolic program and supplying a complete listing.

Each error message or group of error messages is followed on the next line of print-out by the symbolic operation which is determined to be in error.

ERROR MESSAGES

No Operation Inserted

NOP INSERTED

This message is used only in conjunction with another error message. The detected error is identified by its specified message followed by NOP INSERTED on the next line. The NOP instruction is inserted in the program by the assembler and processing continues.

No Input Control Card

NO I/P CTL

This is one of the programed halts listed in Section 7.

The user has failed to enter either the $ I/P CARD or $ PT IN control card. One or the other has to be inserted in the program and the CONTINUE switch on the central processor activated for continuation of the processing.

Invalid Control Card

INVALID CTL CARD

This programed halt indicates the entered card is not one of the specified control cards. The invalid card is read and printed but must be corrected, reinserted, and the processor CONTINUE switch activated before processing can continue.

Sequence Error

SEQUENCE

The current card being checked at the request of control card $ SEQ-CK has a lower sequence number than the preceding card and is therefore out of sequence. Processing continues.

No Object

NO OBJECT

This warning message indicates the user failed to specify the type of object output. Processing continues without an object output.

No Symbolic Output

NO O/P SYM

This warning message indicates the user failed to specify the type of symbolic output. Processing continues without a symbolic output.

Invalid Instruction Label

INSTR LABEL INVALID

The instruction label in columns 16 through 21, which must be left justified, begins with an alpha character and contains no blanks, is in error. The label is not entered; processing continues.

Duplicate Instruction Label

INSTR LABEL DUPLICATED

This instruction label has been previously assigned. The label is not entered; processing continues.

Label Limit Exceeded

LABEL LIMIT

More than 139 labels have been assigned and the Assembler V Program therefore cannot be used as input to the Assembler I Program. Processing continues.

Invalid Field Length

INVALID FLD LENGTH

The field length coded in columns 27 and 28, following an ALF instruction, is other than 0-99 or CC. The entry is bypassed and processing continues.

Previous Invalid Field Length

PRE INV FLD LENGTH

Based upon the contents of the field length of the previous ALF instruction, the following entry should have had a field length marked CC. Processing continues.

Invalid A Parameter Label

A-PAR LABEL INVALID

The A parameter label in columns 29 through 34, which must be left justified, begins with an alpha character and contains no blanks, is in error. A NOP is generated and processing continues.

Undefined A Parameter Label

A-PAR LABEL UNDEFINED

This label in the A parameter was never declared as an instruction label. A NOP is generated and processing continues.

Illegal Entry

ILLEGAL

The A parameter, which should be blank, contains an entry. Processing continues.

Invalid Parameter Range

X PARAMETER INVALID RANGE XXX-XXX

The A, B, or C parameter is indicated with its specified permissable range. Comparison of the print-out following the message to the specified range in the error message shows the detected invalidness. A NOP is generated and processing continues.

Invalid Parameter Character

X PARAMETER INVALID X

This message is used with instructions referring to flags. The A or B parameter with the detected invalid flag is specified in the error message. A NOP is generated and processing continues.

Invalid Increment Field

INVALID INCREMENT FLD

Contents of columns 35 through 38, which should be blank or contain the sign in column 35 and 0-255 in columns 36 through 38, are in error. A NOP is generated and processing continues.

No Label or Increment Error

MUST HAVE LBL OR INC

This message is used with BRU mnemonics only. If the label field is empty, the + or – relative address is assumed as the label. A NOP is generated and processing continues.

Invalid Mnemonic

INVALID MNEMONIC

This mnemonic does not appear in the language specification. The instruction is ignored, a NOP is entered and processing continues.

Invalid Sign

INVALID SIGN RESULT

This message is used with a NUM instruction. The user has used an invalid combination of sign characters. The sign portion of the instruction is ignored whereas the rest is printed. Processing continues.

Invalid Character

INVALID CHARACTER(X)

The detected invalid character of the NUM or MASK parameter is indicated in parentheses. Processing continues.

Word Length Exceeded

WORD LENGTH EXCEEDED

This message is used when either a NUM or MASK instruction is too long to be translated into one word. The overflow is ignored and processing continues.

Memory Assignment Error

MEMORY OVERLAYED ERR

This message informs the user that the specified memory has been previously assigned. Processing continues.

Assumed Memory

MEMORY 512

No memory card has been used to specify the memory size. The assembler assumes a memory of 512 and processing continues.

Memory Capacity Exceeded

STORAGE EXCEEDED

The symbolic program is too large for the specified object memory size. Processing continues with the location counter reset to zero.

End Card

LAST LINE NOT "END"

The user failed to use the mnemonic END card to complete the deck file. Processing continues.

ASSEMBLER VI – SERIES L/TC (40 TRACK) PAPER TAPE VERSION

Assembler VI is a two phase (two pass) version of the Series L/TC Assembler which operates on 40 Track Series L/TC equipment. Each phase is a separate program and must be loaded prior to its operation. The Series L/TC keyboard is used for Phase I input. The output consists of a Phase I listing as well as a symbolic paper tape. This symbolic paper tape is then used as input for Phase II. Phase II output consists of a Phase II assembler listing and an object program tape.

EQUIPMENT REQUIRED

Series L/TC with 40 tracks of user memory–Style A 581 Paper Tape Reader, Style A 562 Paper Tape Punch. Firmware Set 2110100100. The assembler is designed to function with the above standard Firmware Set, which implement the GP 300 language with paper tape input/output.

After the assembly is completed, the desired firmware set must be reloaded before attempting to run applicational programs.

PHASE I

Phase I of Assembler I operates under 3 modes: 1) Keyboard Mode, 2) Correction Mode, and 3) Continuation Mode. Under Keyboard Mode, the symbolic instructions are entered on the Series L/TC keyboard, a Label Table is built up in memory, a Phase I listing is prepared on the printer, and a symbolic paper tape is punched. Under Correction Mode, instructions may be changed, added, or deleted in the symbolic paper tape. Correction Mode allows the Phase I assembly process to be resumed after an interruption. Phase I also has diagnostic facilities for the detection and indication of errors.

PHASE I – INPUT

The input of Phase I of the assembler program is comprised of the labels, symbolic operation codes, parameters and remarks which are entered sequentially via the keyboard or the tape reader (in the case of continuation mode or correction mode).

PHASE I – OPERATING INSTRUCTIONS

In operating Assembler VI, pin fed continuous forms, a minimum of 11-3/4 inches in width, must be used. The left edge of the pin fed form should be at position 10 on the scale and the positioned forms are visible along the bottom form bail. Both Pass I and Pass II object program tapes include their own firmware. Therefore, when loading the assembler programs, all 40 tracks of main memory (words 0-1023) must be unprotected.

1. Via Memory Loader Device: Load in normal manner. (See Section 6 of this manual for specific instructions.)
2. Via Paper Tape Reader:
   a. Load "Memory Load P.T. Reader" into Utility Track with normal load procedure.
   b. From Ready Mode, depress PKA 3 – Utility – and load Pass 1 of Assembler 1 through tape reader.
   c. Execute Assembler Pass 1. See below.

d. Upon completion of all Pass 1 assemblies, depress PKA 3 from Ready Mode to load Assembler Pass 2. Pass 1 assembly does not destroy the Reader Load Routine in the Utility Track.

e. Execute Assembler Pass 2. See below.

f. Upon completion of all Pass 2 assemblies depress PKA 3 from Ready Mode to load in appropriate Main Memory Firmware through Tape Reader, prior to loading and executing any user programs.*

Start

Depress PKA 1, the "START" Key.

The program will stop at a Numeric Keyboard (NK) instruction with three PK's enabled.

The three enabled PK's are:

PKA 2 KEYBOARD MODE OF OPERATION

PKA 3 CORRECTION MODE OF OPERATION

PKA 4 CONTINUATION MODE

OCK's The use of any OCK will allow 15 inches of leader tape (sprocket holes) to be punched and an automatic return to the initial keyboard (NK) instruction.

1. When "MEMORY" prints, enter the number of words of user memory.
2. When "EXTMEM" prints, depress OCK 2, 3, 4 for 32 track; OCK 1 for 40 track.
3. When "PAGE 51" prints, depress OCK 1 for 51 line/page or OCK 2, 3 4 if 66 line/page are desired.

KEYBOARD MODE

Depress PKA 2 to enter the keyboard mode. The program will stop with the numeric keyboard enabled to allow the operator to enter the total words of memory intended for the object program. (Maximum (736). If OCK 1 is depressed 512 will be entered automatically.

Use any OCK to terminate the instruction. The program will then stop in the INSTRUCTION FIELD with the Alpha Keyboard enabled. Failure to enter the total words of memory will inhibit the operator from continuing at the INSTRUCTION FIELD position.

EXTMEM is printed. If a 40 track assembler (OCK 1) is selected, YES is printed. PAGE 51 is printed on the next line. If 51 lines per page is desired, use OCK 1; YES is printed.

Instruction Field

Type the Mnemonic Op Code or Pseudo Op Code, listed on the symbolic program form. See Section 1.

***Keyboard Modifiers for the Commercial Keyboard may be loaded immediately after loading Pass 1.**

The following choices are available to the operator:

OCK 2 Program will return to and stop in the LABEL FIELD. This may be done before or after the entry of the Mnemonic.

OCK 4 Program will stop in the parameter field, but a stop in the remarks field will be enforced before the entry of the instruction is completed.

OCK 1-3 Program will stop in the parameter field without an enforced stop in the remarks field.

PKA 1 Partial Phase I Halt

The use of PKA 1 will permit Phase I to be halted at any time. A special code is punched in the source tape instead of the pseudo operation code END. The label table is printed and punched in the source tape at each stop or "breakpoint." The label table punched at the conclusion of each segment of assembly is updated and all inclusive to that point. In addition, the last operation sequence number is printed and punched. There are two possibilities of continuing the assembly of the program. The first possibility is that the next section of the program will be assembled before the status of the assembler program in the machine has been disturbed. In this case, it is only necessary to enter the continuation mode and proceed. The second possibility is that the continuation will be at some later date when all current information in the system has certainly been destroyed.

In this case, it is necessary to load the Phase I assembler program and the label table along with the ending sequence number, both of which were printed and punched at the time of the "breakpoint," enter the continuation mode and proceed.

The partial Phase I halt, or breakpoint makes it possible to assemble large programs in sections.

The special code used for the breakpoint makes it possible to use small sections of Phase I source tape for input to Phase II. The breakpoint code will halt Phase II at a keyboard instruction, as described in Phase II operation, and the use of any OCK will permit Phase II to continue.

PKA 8 Will print "ERROR" in red at left of sequence number column, the form will space and the program will stop in the Instruction Field for re-entry.

The entry of an Invalid Mnemonic will function in the same manner as the depression of PKA 8.

The typing of the Pseudo-Op word END will cause the program to enter a routine where the label table will be printed and punched out. The program will then allow the system to return to the READY MODE.

Label Field

Type in the Label – a maximum of 6 characters is permissible. The first character must be an Alpha character. A maximum of 256 labels may be used.

OCK's Use of any OCK to terminate the field will cause the program to skip to the PARAMETER FIELD IF THE INSTRUCTION FIELD has been previously entered. If not, the program will stop in the INSTRUCTION FIELD.

Use of OCK 4 will also enforce a stop in the REMARKS FIELD before the line is completed.

PKA 8 Will print "ERROR" in red at left of sequence number column, the form will space the program and the program will stop in the Instruction Field for line re-entry.

If a duplicate label is entered, the same function will occur as if PKA 8 had been depressed.

Parameter Field

The Parameter Field may actually be a 1, 2 or 3 field entry, depending on the Mnemonic entered in the Instruction Field. Either the Alpha Keyboard or the Numeric Keyboard will be enabled at this time, also depending on the Mnemonic.

OCK'S Use of OCK 2 before the entry will change the entry mode from ALPHA to NUMERIC or from NUMERIC to ALPHA; however, the program will allow this switch only if the Mnemonic permits it. (i.e., some Mnemonics may only have a LABEL).

ALPHA ENTRY Enter the appropriate Alpha Characters. A maximum of 6 characters is permitted on labels.

NU-MERIC ENTRY Enter appropriate numeric digits. Where a zero entry is not permitted or where the numeric entry exceeds the value permitted by the Mnemonics, the program validation routine will re-initiate a numeric keyboard instruction until the operator indexes a valid entry.

OCK 1 The program will stop in the next PARAMETER FIELD if the Mnemonic calls for another field entry. If the parameter field entry is the ending parameter field entry, the program will print the sequence number, the form will space and the program will stop in the INSTRUCTION FIELD for the next entry. If OCK 4 had been used in any previous entry position, after printing the sequence number, the program will stop in the REMARKS FIELD before ending the line entry.

OCK 3 The program will stop to permit entry of a +/– increment (numeric).

OCK 4 On the ending Parameter Field entry, after printing the sequence number, the program will stop in REMARKS FIELD before ending the line entry.

PKA 8 Use of this PK will print "ERROR" in red at the left of the sequence number column, the form will space and the program will stop in the INSTRUCTION FIELD for re-entry.

If an Invalid Alpha key has been used, the same function will occur as if PKA 8 had been depressed.

+/– Increment

The numeric keyboard is enabled. The numeric entry may be up to 255. Use of the RE key prior to termination, will permit a MINUS value; otherwise, the entry will be positive.

OCK 1, 2, 3 These OCK's will print the sequence number, space the form and stop in the INSTRUCTION FIELD for the next line entry. If OCK 4 has been used previously, at any time in the symbolic entry, the sequence number will be printed and the program will stop in the REMARKS FIELD.

OCK 4 Enforces a stop in the REMARKS FIELD.

PKA 8 This PK will print "ERROR" in red at left of the sequence number column, the form will space and the program will stop in the INSTRUCTION FIELD for re-entry.

Remarks Field

Typing of up to 25 Alpha characters for remarks is permitted. The entry of a 26th character will result in a keyboard Error condition. The program will be halted. The RESET key must be used to correct the error condition and an OCK used to terminate REMARKS FIELD correctly. Remarks are not punched into the output tape until all typing is completed and the instruction terminated by the use of an OCK. The form will space and the program will stop in the INSTRUCTION FIELD for the next entry.

Alf Pseudo-Instruction

The entry of the pseudo-op ALF will permit the entry of up to 24 alpha characters as a constant. The entry of from 1 to 23 characters followed by OCK termination will cause the program to allocate the correct number of words for the message. The program will then stop in the INSTRUCTION FIELD for the next entry. The entry of exactly 24 characters and termination will cause the program to allocate the words and, in addition, the program will automatically print ALF in the INSTRUCTION FIELD on the next line and then stop for an additional alpha constant entry. The entry of a 25th character will result in a keyboard error condition. The RESET key must be used to correct the error condition and permit the proper termination by an OCK. However, the word ALF will still print in the INSTRUCTION FIELD with a stop to allow for an additional alpha-constant entry.

CONTINUATION MODE

In addition to loading the Assembler program tape Phase I, using the standard program load procedures, the label table must also be loaded into memory. The tape perforator must be turned on and sufficient leader tape (sprocket holes only) punched. The RESET KEY will return the machine to the READY MODE.

PKA 4 This will cause the sequence number printed out with the first line of entry and to be in proper sequence with the last sequence number from the previous section of tape, prior to the breakpoint. The program will then enter the KEYBOARD MODE portion of the Assembler program, Phase I for continuation.

CORRECTION MODE

Depression of PKA 3 will cause the CORRECTION MODE of operation to be entered. The program will stop at a NUMERIC KEYBOARD instruction. At this point, enter the memory size for which the object program is being assembled. Depress any OCK. The program will then stop at a NUMERIC KEYBOARD instructions with three (3) PK's enabled. At this point, the source tape must be loaded in the A 581

Tape Reader and the A 562 Tape Perforator must be on. The enabled PK's determine the following functions:

PKA 5	ADD TO
PKA 6	CHANGE
PKA 7	DELETE

Add to Sequence Number – PKA 5

At the numeric keyboard entry which is reached via PKA 3, prior to depressing PKA 5, index the sequence number of the symbolic entry, from Phase I documentation, that precedes the area in which instructions are to be added. "ADD" will print followed by the sequence number.

The program will automatically read the source tape, punch out a new tape, and will build a label table in memory. When the sequence number indexed has been read and punched, the program will print the sequence number plus .1 (XX.1). This provides the ability to add one symbolic instruction in the position following the sequence number indexed (XX) with a sequence number of XX.1. Following the entry of this added symbolic operation, the program will return to the Correction Mode. To successively add a group of instructions, PKA 5 must be depressed prior to each added instruction. Re-entry of the sequence number isn't required. The added instruction will be automatically inserted and numbered in .1 increment. The number of "ADD TO" instructions is not limited, but when .9 is exceeded, duplicate sequence numbering will result.

Example: If instruction sequence number 23 is incremented by ten .1 increments, the result would be a duplicate sequence number 24.0. Further "ADD TO" instructions would cause this sequence number to in turn be incremented (24.1, 24.2, etc.). The original instruction listed as 24.0 will appear in the output tape immediately following the last instruction added.

Re-entry of the original instruction is not required, however, duplicate sequence numbering can lead to difficulty in later correction of the source program; therefore, the original 24.0 sequence number should be "deleted" then a new sequence number "added." See Deletes From Source Tape paragraph.

Change Source Tape – PKA 6

At the numeric entry reached by depressing PKA 3, prior to the depression of PKA 6, index the sequence number from the Phase I documentation that is to be changed. When the instruction is terminated by PKA 6, "CHG" will print followed by the number indexed.

The program will automatically read the source tape, punch out a new tape and will build a label table in memory. When the sequence number indexed has been read, it will not be punched out. The program will enter the Keyboard Correction Mode to permit entry of a line of coding as described in section 3.2 following the entry of the changed symbolic operation, the program will return to the Correction Mode.

The assembler program permits instructions to be changed and new instructions immediately added to the program.

Depression of PKA 6 without a sequence number being indexed, will cause the very next instruction on the source tape to be read in but not punched out. If this is not the sequence number that was to be changed, the instruction would have to be entered via the keyboard.

Delete From Source Tape – PKA 7

At the numeric entry reached by the use of PKA 3, prior to the depression of PKA 7, index the sequence number, from the Phase I documentation that is to be deleted. When the instruction is terminated by the use of the PKA 7, "DEL" will print followed by number indexed. The program will automatically read the source tape, punch out a new tape and will build a label table in memory. When the sequence number indexed has been read, it will be ignored and not punched. Once deleted on first correction pass, that sequence number is gone and will never be found on any subsequent correction pass. The Assembler permits instruction deletion immediately followed by the addition of a new instruction. The program will return to the Correction Mode.

Depression of PKA 7 without a sequence number being indexed, will delete the next sequence in the tape and print out the sequence number deleted. This would of course result in an incorrect object program since an instruction was deleted that should not have been deleted.

Source Tape Interrupt Procedures

After indexing a sequence number and depressing any of the PK's described above, if the operator realizes that the wrong sequence number was entered, PKA 8 may be depressed. At the end of the line, the program will print out, "NOW AT" followed by the last sequence number read in and the program will stop at the Keyboard entry with the three (3) PK's enabled.

End Procedure

When the last "ADD TO," "CHANGE" and "DELETE" has been entered, the entry of any sequence number larger than the END sequence number, from Phase I documentation, will read the source tape and punch a new one. When the word END is read, it will cause termination of the Phase I correction routine and will then follow the END pseudo instruction procedure.

Label Table Option

When the END Psuedo instruction has been entered, the program will print:

PRINT LABEL TABLE

The use of OCK 2, 3 or 4 will terminate the program without either printing or punching a label table.

If OCK 1 is depressed, the program will print:

YES
PUNCH LABEL TABLE

If OCK 1 is depressed the label table is both listed on the printer form and punched in the output tape.

If OCK 2, 3 or 4 is used, the label table will be listed on the printer form, but will not be punched in the output tape.

PHASE I – CONDENSED OPERATING INSTRUCTIONS AND REFERENCE LIST

1. Turn on tape perforator.
2. Be in READY MODE.
3. Depress PKA 2 (Load).
4. Depress MEMORY LOAD switch.
5. Read Phase I tape in PROGRAM LOADER.
6. After tape is read in, depress MEMORY LOAD switch.
7. Depress RESET key to return to READY MODE.
8. Depress PKA 1.
9. Depress PKA 2 for Keyboard Mode.
10. Type total words of memory you intend to use.
11. Depress any OCK and it will space correctly and stop for you to type the Op code of the first instruction. (Col. 22-26 on coding forms.)
12. Type OP Code.
13. Use one of the following 3 lists of instructions:
    a. No remarks (Col. 53)
       No label (Col. 16)
       1) Depress OCK 1 or 3
       2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 1 or 3 after each parameter entry.
       3) The final OCK will space for next Op Code entry.
    b. No label (Col. 16)
       Remarks present (Col. 53)
       1) Depress OCK 4.
       2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 1, 2 or 4 after each parameter entry.
       3) Final OCK will space to remarks field. Type remarks.
          Depress OCK 1 to space to next OP code entry.
    c. Label present (Col. 16)
       1) Depress OCK 2.
       2) If parameters are required, it will stop in each necessary parameter field. Type parameter. Depress OCK 2 after each parameter entry.
       3) Final OCK will space to label field. Type label.
       4) If no remarks, depress OCK 1 to space to next Op code entry.
       5) If remarks present, depress OCK 4. Type remarks. Depress OCK 1 to space to next Op code entry.

Typing Error

If mistake made, depress PKA 8 before an OCK. It will print ERROR and will stop in Op code field for re-entry of instruction.

+ and – Increment

Correction Mode

1. Turn on perforator and put Source Tape in reader.
2. Be in READY MODE.
3. Depress PK 1.
4. Depress PK 3.
5. Type memory size and OCK 1.

Add To

1. Type sequence number before area to be added.
2. Depress PKA 5.
3. Program will read source tape, punch new tape, build label tapes.
4. When indexed sequence number has been reached, .1 will be printed beside it.
5. Add new instruction as other original instruction.
6. If there are additional instructions, depress PKA 5 and type next instruction.

Changing Source Tape

1. Type number to be changed.
2. Depress PKA 6.
3. Sequence number will not be punched.
4. Enter new instructions as original instructions.

Delete from Source Tape

1. Type sequence number.
2. Depress PKA 7.

Sequence Number Typing Error

1. Depress PKA 8.
2. Depress PKA 5, 6 or 7 again.

To Terminate any Correction

1. Enter any sequence number larger than the END sequence number then depress PKA 5, 6 or 7.

2. It will read source tape and punch a new one. This will give new symbolic tape and new label table.

PHASE I – DIAGNOSTIC FACILITIES

Provision is made for the detection and printed indication of errors that may occur in the Assembler program.

ERROR DETECTION AND INDICATION

The entry of the symbolic language in Phase I, as previously stated, is via the keyboard or paper tape reader. Errors are detected as the symbolic entry is made.

Mnemonic Error Detection

The mnemonic is entered first in sequence. If the mnemonic is invalid, the OCK used to terminate the entry will initiate an error sequence that will space the print head to position 10, print ERROR, align the form 1 space, and re-position the print head so that the invalid mnemonic may be corrected.

Label Error Detection

The next sequential operation, in the entry sequence of the program, is the entry of a label if required. The label error detection consists of determining if the label has been used previously and/or if the total number of labels exceeds the maximum of 256.

Duplicate label validation occurs after the specific symbolic operation has been entered. If the label is invalid, the print head is positioned to 10, ERROR is printed, and the printer document is aligned 1 space and a corrected entry must be made.

If the maximum of 256 labels is exceeded, the printer document advances to the next form (over fold), prints and punches out the contents of the label table up to that point. The assembler program will return the system to the ready mode and the correction routine must be used.

Parameter Error Detection

The parameters are also validated following the termination of their entry. Label-type parameters are not validated in Phase I. Separate error detection is used for numeric parameters and alpha parameters.

Numeric Parameter Error Detection

Two numeric parameter conditions are validated in Phase I.

1. Parameter exceeds specified limits (maximum or minimum) value.
2. Parameter is required and has not been entered.

In both cases, the validation routine will, upon recognizing the invalid condition, re-initiate the parameter entry sequence. However, if a zero parameter is acceptable, it is not necessary to index a zero. Leaving the parameter area blank will force the zero entry.

Alpha Parameter Error Detection

An alpha parameter error is detected upon termination of the entry. In an invalid situation, such as entering an invalid alpha character, or no entry where an alpha entry is required, the print head will be positioned to 10, ERROR is printed, the printer document aligned 1 space and the entire symbolic operation sequence must be re-entered.

Memory Error Detection

Memory error conditions are:

1. The program exceeds the maximum memory available.
2. A specific point in the program is reached where sufficient memory has been occupied such that specifying a REG instruction, with a large parameter, will exceed the maximum memory available.

   In both of the above error conditions, the assembler program will return the system to the Ready Mode. This condition can only be corrected by use of the correction routine.

ERROR DETECTION – CORRECTION MODE

The correction mode features error detection similar to that previously discussed.

Mnemonic Error

If an invalid mnemonic is encountered, the validation routine will print the sequence number, label – if any – and the mnemonic as it appears in the input tape, align the form 1 space, print INSTR ERROR, punch a NOP instruction in the output tape and continue assembly.

Label Error

If an invalid label is encountered, the validation routine prints the sequence number, label and instruction as it appears on the input tape, aligns the form 1 space, prints LABEL ERROR, removes the invalid label, but punches the rest of the instruction in the output tape and continues assembly.

Parameter Error

If an invalid PSEUDO Instruction parameter is encountered, the validation routine prints the sequence number, label, and instruction, aligns the form 1 space, prints PARMTR ERROR, punches the instruction in the output tape and continues.

PHASE I – OUTPUT

The output of Phase I of Assembler I consists of a print-out and a punched paper tape (source tape).

PHASE I – PRINT-OUT

The Phase Print-Out is the same format as the Phase I output tape. It is in two sections, the first is a listing of the Symbolic operations and the second a listing of the label table with memory addresses, as illustrated in Exhibit I.

```
     MEMORY 512
     EXTMEM YES
     PAGE51 YES
 1              NOTE
 2              LPNR        PMASK
 3              LPKR        PKEYS
 4    START     CLM         TOTAL
 5              AL          1
 6              POS         LIST
 7              PKA         12
 8              NKRCM       AMOUNT
 9              PNS-        PRINT
ERROR           SK          J
10              SK          K                2      2
11              ADM         TOTAL
12              PC-         -
13              EX          K                2      1
14              PCP         #
15              BRU         START  +1
16    PRTSUB    SRJ         COMR
17              PC-         C
18              PC+         S
19              BRU         START  +1
20    PRTOT     SRJ         COMR
21              PC-         CR
22              PC+         *
23              BRU         START
24    COMR      TRA         TOTAL
25              PNS-        PRINT
26              POS         SYMBOL
27              SRR         1
28              WORD
29    PKEYS     BRU         PRTSUB
30              BRU         PRTOT
31    PMASK     MASK        Z,ZZZ,ZZZ,ZZZ,ZZZ.DD
32    TOTAL     REG         1
33    AMOUNT    DEFT        15               0
34    PRINT     DEFT        14               0
35    LIST      DEF         10
36    SYMBOL    DEF         32
37              END
```

ADDING MACHINE

TO SUBTOTAL AND TOTAL
LIST OCK 1 = AMOUNT

OCK 2 = NUMBER

PRINT SUBTOTAL

PRINT TOTAL

COMMON TOTAL ROUTINE

BASIC ASSEMBLER VI — PHASE I — EXHIBIT 1

PHASE I – OUTPUT TAPE

The output tape is created in two sections. The first section is the symbolic operation codes, complete with parameters and remarks, with the addition of a sequence number and the decimal equivalent of the actual location of the instruction in memory, punched in USASCII.

The format is:

Sequence Number

Decimal equivalent of the actual memory location of the operation.

Label (If entry is labeled)

Symbolic Operation Code

Parameters

Remarks

The second section of output tape (if specified by option) is separated from the first section by approximately ten inches of unpunched tape. This is the label table and is punched in compact format hexadecimal which is the same format punched for the object program.

The format is

Label

Memory Location

PHASE II

Phase II of Assembler I used a symbolic (source) paper tape as input and provides an object program tape which operates on a Series L/TC computer. It also provides a program listing with the object code as well as the symbolic code for each instruction and the absolute memory assignment. Phase II is also equipped with diagnostic facilities for the detection and indication of Phase II errors.

PHASE II – INPUT

The input to Phase II of the assembler program is the label-table tape, which has been separated from the symbolic tape and loaded via the program loader and the symbolic operation tape (source tape) which is mounted on the optional A 581 paper tape reader and entered under assembler program control.

PHASE II – OPERATING INSTRUCTIONS

The Phase II Assembler program must first be loaded into memory using the standard program load procedure. In addition, the same type of continuous pin feed forms must be used, with the forms positioned with left edge at position 5. If Phase II is being run immediately after running Phase I, it is not necessary to load the LABEL TABLE into memory. If Phase II is being run at any other time, it will be necessary to load the LABEL TABLE. This table is at the end of the source tape which is the output from Phase I. The table is separated from the source tape (sprocket holes only), is punched in compact hexadecimal format and must, therefore, be loaded via the program loader. When this procedure is complete, the RESET KEY must be depressed to return the machine to the READY MODE.

Start

PKA 1 The program will stop at an Alpha Keyboard entry position to permit the typing of up to 6 alpha characters for any identification purposes desired.

At this point, the Symbolic output (source) tape from Phase I must be loaded on the A 581 tape reader and both the tape reader and tape punch switches turned on.

Depression of any OCK will cause the program to enter the automatic mode. This mode reads the source tape. Complete documentation is printed out, including the hexadecimal object program coding and all remarks. An object program will also be punched out.

The Assembler program Phase II will automatically put the machine into the READY MODE, when the Pseudo-Op END at the end of the source tape is read.

PKA 8 This PK effects an interrupt. Operation can be resumed by the use of any OCK.

PHASE II – CONDENSED OPERATING INSTRUCTIONS AND INDEX

1. Turn on tape perforator.
2. Be in READY MODE.
3. Depress PKA 2 (Load).
4. Depress memory load switch.
5. Read Phase II tape in PROGRAM LOADER.
6. After tape is read in, depress MEMORY LOAD switch.
7. Depress RESET key to return to READY MODE.
8. At this point, if Phase I has not been run immediately prior to this, it will be necessary to load the label-table into memory using the same load procedure as in loading Phase II above. Then return to READY MODE.
9. Depress PKA 1.
10. Type up to 6 alpha characters for program identification and then OCK 1.
11. Insert symbolic tape into reader and depress READ switch.
12. This will give you a complete program listing and object tape.
13. If you have error in program it will be necessary to go to Phase I documentation for changes or to hexadecimally change program.

PHASE II – ERROR DETECTION AND INDICATION

As stated previously, the input to Phase II is the output tape, or source tape, from Phase I.

Error detection in Phase II is supplemental to the error detection in Phase I and is designed to validate the assignment of actual machine language, which is function of Phase II, plus the provision to indicate the possibility of machine-inflicted error, and the possibility of remote combination of programs vs machine logic which could cause misinterpretation of the symbolic entries.

ASSEMBLER VI

WORD	SYL	OBJECT CODE	SEQ NO.	SYM. LOC.	MNEM OP.CODE	A-PARAMETER LABEL	INC	B-PAR	C-PAR	LABEL ADDR.	REMARKS
			1		NOTE						ADDING MACHINE
0	0	F808	2		LPNR	PMASK				8	
	1	FC07	3		LPKR	PKEYS				7	
	2	D809	4	START	CLM	TOTAL				9	
	3	ED01	5		AL	1					
1	0	EB09	6		POS	LIST				10	
	1	F603	7		PKA	12					TO SUBTOTAL AND TOTAL
	2	A0F0	8		NKRCM	AMOUNT				15 0	LIST OCK 1 = AMOUNT
	3	D1E0	9		PNS-	PRINT				14 0	
2	0	4294	10		SK	K		2	2		
	1	8009	11		ADM	TOTAL				9	OCK 2 = NUMBER
	2	C52D	12		PC-	-					
	3	4594	13		EX	K		2	1		
3	0	C123	14		PCP	#					
	1	7C00	15		BRU	START	+1			0 3	
	2	2805	16	PRTSUB	SRJ	COMR				5 2	PRINT SUBTOTAL
	3	C543	17		PC-	C					
4	0	C453	18		PC+	S					
	1	7C00	19		BRU	START	+1			0 3	
	2	2805	20	PRTOT	SRJ	COMR				5 2	PRINT TOTAL
	3	C55D	21		PC-	CR					
5	0	C42A	22		PC+	*					
	1	7800	23		BRU	START				0 2	
	2	3809	24	COMR	TRA	TOTAL				9	COMMON TOTAL ROUTINE
	3	D1E0	25		PNS-	PRINT				14 0	
6	0	EB1F	26		POS	SYMBOL				32	
	1	0400	27		SRR	1					
			28		WORD						
7	0	7803	29	PKEYS	BRU	PRTSUB				3 2	
	1	7804	30		BRU	PRTOT				4 2	
			31	PMASK	MASK	Z,ZZZ,ZZZ,ZZZ,ZZZ.DD					

Mnemonic Error Detection

The mnemonic is validated again in Phase II. At this particular point in assembler program progression, the potential error possibility is the misreading of the mnemonic as a result of a mispunch, some internal system failure or reader failure. In any event, an invalid mnemonic in Phase II is an irrecoverable error and will cause the validation sequence to return the system to the ready mode.

Parameter Error Detection

Parameters are again validated in the same manner as described in Pages 5-xx through 5-xx. In addition, if a label is used to define a parameter, the actual value of the label is validated.

For all parameter errors, except label errors, the word ERROR is printed starting in position 45, the printer escapes one space and PARMTR (parameter) is printed.

In the event of a parameter-label error, the word ERROR is printed starting in position 45, the printer escapes one space and LABEL is printed.

For all instructions that are in error, a NOP instruction is substituted, printed out in the instruction sequence, and punched in the object program tape. The end result is that the object program tape contains NOP instructions instead of invalid instructions; plus, the program provides documentation which defines the location and type of parameter error.

CORRECTION ROUTINE PHASE II

Phase II errors are corrected by using the Source tape (tape output from Phase I) and the Assembler Phase I correction routine, or correcting the Symbolic language and restarting the entire program. Corrections in the object program can be made by using the Memory Modify service routine with a corrected object tape generated with the Punch from Memory service routine.

PHASE II – OUTPUT

The output from Phase II of Assembler I consists of a print-out and an object program tape.

PHASE II – PRINT-OUT

The Phase II print-out is a complete print-out of the object program along with explanatory information. The format is illustrated by Exhibit II.

PHASE II – OUTPUT TAPE

The Assembler program Phase II output tape is the object program tape and is punched in compact hexadecimal format. It contains the complete program, in machine language, ready to be loaded directly into the Series L/TC computer.

SECTION 6

OBJECT PROGRAM LOADING

MEMORY LOADER DEVICE

The memory loader is a special purpose paper tape reading device which automatically loads programs into memory. The memory loader is located at the lower left-hand corner of the keyboard. It contains a self-threading paper tape cartridge (removable), a feeding device, and a tape reader to read program tape into memory. This device is under control of the Memory Load Switch (enabled by PK2-(load) – in the Ready Mode).

The Memory Loader is capable of reading program tape at a rate of 15.5 codes per second. Program tape (8 channel) is inserted into the lower slot of the self-threading tape cartridge with the reference edge (three punched holes below the feed holes) of the tape to the right. The tape is ejected through the upper slot.

This device is used only to load object tapes for the initial loading of memory.

A 581 PAPER TAPE READER

Load the Reader Memory Load Service Routine using the procedure outlined under Memory Loader Device. The Reader Memory Load Service Routine permits the loading of an object program paper tape with the paper tape reader.

If the machine is "off," depress Power-On Button (30 seconds to Ready Mode) or if machine is on, depress READY button to return to READY mode.

Turn the tape reader on. Load the object program paper tape to be read. Depress Read Key on Tape Reader. Depress PKA 3 (utility key). The tape will be read and the object program loaded into memory. The loading will stop when the tape has been completely read. Depress the ready button to exit the routine.

When the paper tape reader is used to read in object tapes assembled on the B 5500, a special L/TC 500 utility program must be used instead of the Reader Memory Load Service Routine. See the section entitled "L/TC 500 Assembler IV for B 5500 Systems."

MEMORY LOAD (80-COLUMN CARD)

This Memory Load Utility Routine permits program to be loaded from 80-column cards. This routine resides in the Utility Track (Track 2, Block 2 beginning with word number 578) and hence cannot be resident in memory along with any other Utility Routine that would also occupy the same memory space.

NOTE: This routine must be resident in the Utility Track to permit use of the LCD instruction.

THE PROGRAM CARD FORMAT

Card Column	
1 - 6	Program Identification (Alpha)
9	Beginning Word Number (hexadecimal value for word 0 to 255)
11 - 10	Number of Program Words on Card (Decimal 1 to 8)
11 - 15	No Significance – but are included in "hash total"
16	Block Number Block 0 = blank card column Block 1 = decimal 1
17 - 24 25 - 32 33 - 40 41 - 48 49 - 56 57 - 64 65 - 72 73 - 80	Up to 8 words of program Each word occupies 8 card columns. Each card column contains binary value for 2 hexadecimal digits of word.

The Memory Load Program will accumulate a "hash total" of all cards read. This "hash total" and the Program Identification (ID) may be printed out at the end of the load routine if the operator so desires.

The program cards will load into memory at the rate of approximately 102 cards per minute. Each program card may contain from 1 to 8 words of program.

80-COLUMN CARD MEMORY LOAD OPERATING INSTRUCTIONS

1. The Card Memory Load Routine must be loaded into memory using the Memory Loader Device as explained previously.
2. From a READY mode, depress PKA 3. If the program deck has already been placed in the Card Reader supply hopper and the RESTART button depressed, the cards will be read and loaded into memory. When the last card is read and the supply hopper is empty, the Reader Condition Indicator on the Series L will be turned on. The operator has the following choices:
   a. If more cards are to be loaded, place them in the hopper and depress RESTART Key.
   b. If the Program ID and Hash Total are to be printed, depress ANY key on either keyboard. The Hash Total will print followed by the Program ID and then the machine will return to the READY mode.
   c. Depress the READY push button and the machine will return to the READY mode immediately without printing either the Hash Total or the Program ID.

NOTE:

1. **This routine destroys the contents of the Accumulator.**
2. **The program ID is stored in word 01 during loading. Thus, if program data must be loaded in word 01, that program card must be placed as the last card in the deck.**

	OP CODE	A	B
LOAD MEMORY FROM CARD	LCD	0-255	

See Page 2-96.

BCL CARD MEMORY LOAD OR TRANSLATE BCL CARD FORMAT TO L CARD LOAD FORMAT (B 5500/B 300 ASSEMBLER OUTPUT)

This program will permit memory to be loaded from cards created on a B 5500 or a B 300, or will permit these cards to be read and new cards punched in the Series L Card Memory Load format (compact hexadecimal).

This Utility program occupies the Utility Track (Track 2, Block 2) and hence cannot be resident in memory along with any other Utility Routine that also would occupy the same memory space.

In addition it occupies words 192 to 223 (Track 6 of Block 0). If the Memory Load portion of this Utility program is used, Track 6 will be overlayed with any program being loaded into this part of memory.

A Card Reader Style A 595 and a Card Punch Style A 142 are required. The Card Punch is only required if the translation from BCL card to Series L hexadecimal card format is needed.

OPERATING INSTRUCTIONS

1. After loading Utility Program, use PKA 3 from the READY Mode. Program will stop on a Numeric Keyboard. The following choices are available. BCL Card Deck must be loaded in Card Reader.

   OCK 1, 2 or 3 – MEMORY LOAD

   OCK 4 – PUNCH IN L CARD FORMAT

   A card with a zero punched in card column 12 will cause the machine to return to the READY Mode.

2. If the Card Punch is used, a card must be positioned under the Read Station as well as the Punch Station. The print switch should be in the off position.

3. The card with the zero punch in row 12 will be created by the B 5500 or B 300 Assembler. If it is lost, it should be replaced before running this Utility Program. A manual return to the READY Mode may cause loss of data.

If cards are not present in the Card Reader, the Reader Condition Indicator light is turned on, flag R1 is set, and the instruction is held up pending operator action.

The 12 positions of each card column are compressed into 8 bits during reading to permit placing that code into 2 digits of memory; however, that 8 bit format does not conform to the internal code set.

Therefore, the code undergoes translation when accessed by the other instructions described in this section. The card codes are compressed into 8 bits in the following manner:

Card Column Punching	Character Position in Card Read Area Upper Digit Bits 8 4 2 1	 Lower Digit Bits 8 4 2 1
12	X	
11	X	
0	X	
1		X
2		X
3		X X
4		X
5		X X
6		X X
7		X X X
8		X
9	X	

PUNCHED PAPER TAPE OBJECT TAPE CODE

An object tape generated by Phase II of an assembly will look like the example on Page 6-5. Each channel on the tape is made up of eight bits – four upper bits and four lower bits. Each element containing instructions consist of eleven columns.

The first column contains the start of message indicator; an eight and two bit, in the upper four bits and the block number in the lower four bits. The block number is zero for words 0-255 and one for words 256-512.

The second column contains the word number and may use all eight bits or just a couple of the bits. For example, word 21 would be represented by:

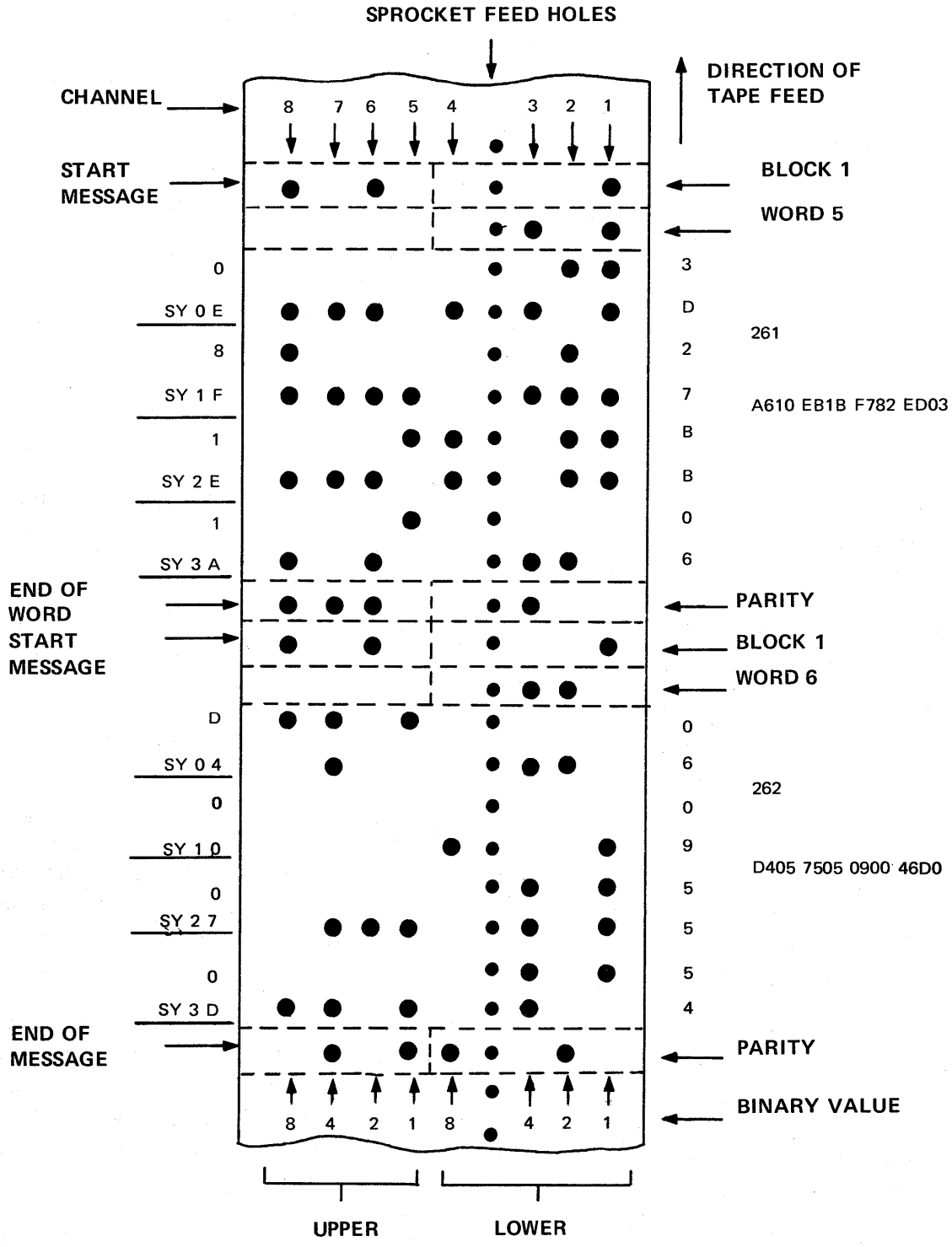
8 7 6 5 4 3 2 1 channels; word 255 by 8 7 6 5 4 3 2 1 channels.

The next eight columns contain the four syllables of the word, with one instruction per syllable. Each character of an instruction occupies four bits so that one instruction takes up two columns. The first syllable of a word, the "0" syllable, follows the word number, so that the sequence of syllables on the tape is 0, 1, 2 and 3 in that order.

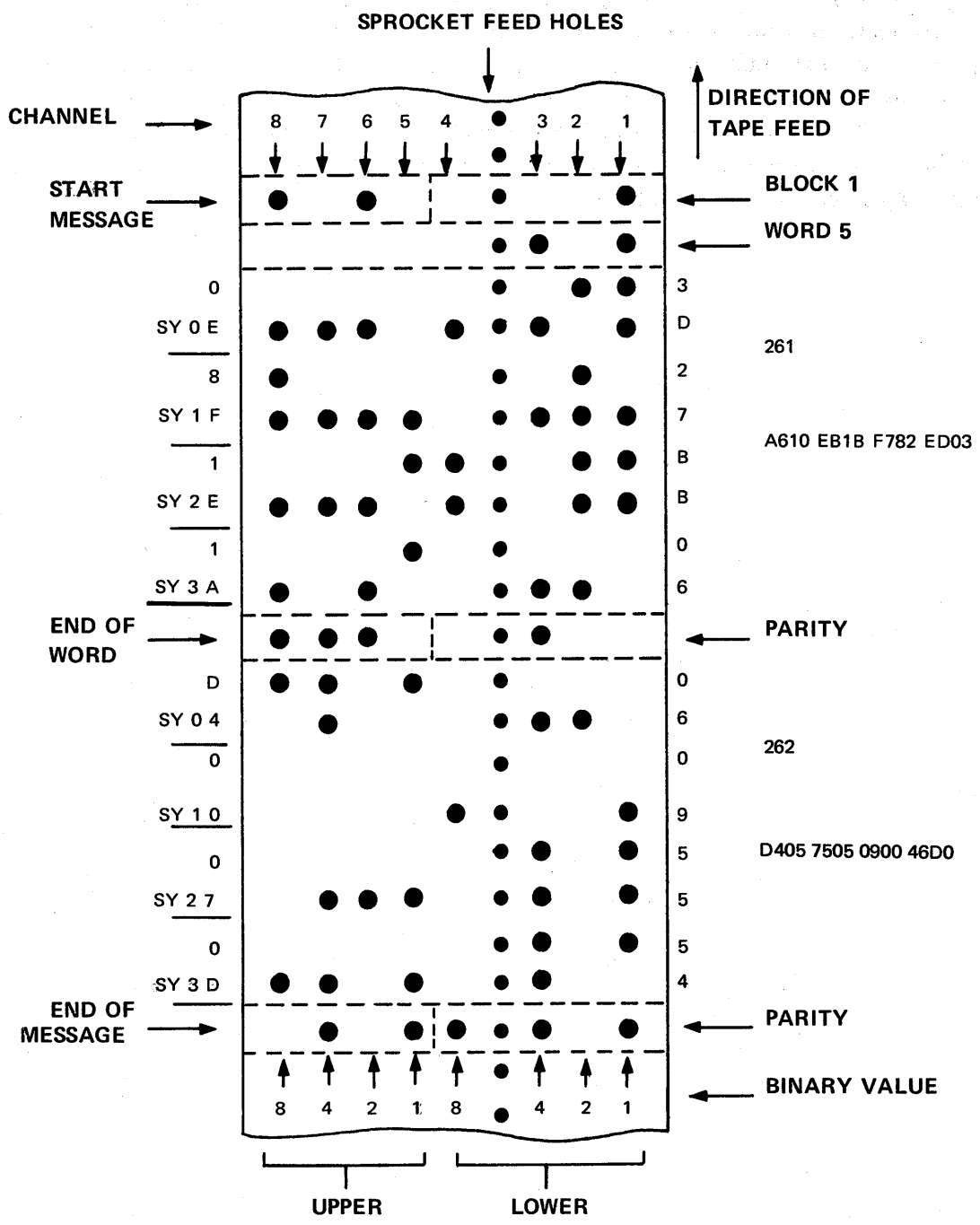
The last column of the element contains an end of message code in the upper four bits and parity bits in the lower four bits. The end of message code, a four and one bit, is used most often as the code in the last column of the element. But sometimes an end of word code, an eight, four and two bit, is used as the code in the last channel instead of the end of message code. Either one or the other of the two codes will be used as terminating codes on a tape; but both codes are not used on the same tape due to the nature of the tape generator.

The lower four bits of the last column contain parity bits. Parity is even on the TC and L series. If a bit is punched in the third channel, binary value four, of the tape, that means that the total number of punches in the two channels with a binary value of four (i.e., channels three and seven) is odd. For example, look at the example on the next page, word 261. There is a parity punch in the binary value

PUNCH PAPER TAPE COMPACT OBJECT CODE



PUNCH PAPER TAPE COMPACT OBJECT CODE PUNCHED FROM MEMORY



four of the four lower bits. Add up the punches in channels three and seven, including the punches in the block number and the word number. There are seven punches which is odd so the one punch in the parity block makes it even.

An object tape created by using the Punch from Memory Utility Routine will look like Example 2. (Example 2 is basically the same as Example 1 except for three items. The differences in Example 2 are: (1) There is only one word number punched – the number of the first word punched from memory; (2) Each word will have an End of Word code (an 8,7 and 6 punched in the upper four bits of the column) except for the last word which will have an End of Message (a 4 and 1 punch in the upper four bits of the column.) (3) Example 2 does not contain two columns – the start of message, block column and the column containing the word number.

GLOSSARY

ACCESS TIME	The amount of time required for a computer to locate and transfer a character of data from its storage position and make it available for processing.
ACCUMULATOR	A working numeric memory location containing 15 digit positions and a flag position.
ALPHA CHARACTER	A character chosen from A-Z.
ALPHANUMERIC CHARACTER	A character chosen from A-Z or 0-9 and other specially designated characters.
ASSEMBLER	A program written to convert a symbolic program to a corresponding program in machine language. Principally designed to relieve the programmer of the problem of assigning actual storage locations to instructions and data when coding a program and to permit the use of mnemonic operation codes rather than numeric.
BASE WORD	The first word in a table.
BINARY CODE	A coding system in which successive digits reading from right to left are interpreted as successive powers of two.
BLOCK	A memory block consists of 256 words.
BRANCH	The point in a program at which the machine will proceed with one or two or more existing possible routines according to existing conditions and instructions.
BUFFER	A temporary storage area used to hold data until the data can be accepted for processing.
CARD FIELD	A set of card columns fixed in number and position into which the same classification of information appears.
CHARACTER	A graphic symbol of any sort.
CLEAR MEMORY WORD	A memory word consisting of zero.
CODING FORM	A form upon which coding is placed.
COMPUTER	A machine for carrying out calculations and performing specified transformations of data.
CONSTANT	A magnitude which does not change its value.
CONTROL AREA	The area which contains the firmware which determines system control functions.

DEBUGGING	The process of removing problems from the program so as to meet the program specifications.
DIGIT	Any of the figures 0-9.
DOCUMENTATION	The explanatory remarks included by a good programmer.
ERROR	The amount of precision lost in a quantity. The difference between an accurate quantity and its calculated approximation. Errors occur in numerical methods; mistakes occur in programs, coding, data transcription, and operation; malfunctions occur in computers.
FIRMWARE	A control program, stored in the systems memory. The firmware identifies each instruction used by the program and selects the proper "micro string" to perform the functions of the instruction.
FLAG	An indicator which is set or reset upon execution of certain instructions, which provides a test factor to determine whether or not the conditions specified by the program exist, so that alternate paths of the program may be selected.
FORMAT	An arrangement of information on a form or into storage.
HARDWARE	Physical equipment.
INPUT	The information fed into a computer system, in the form of numbers or letters, from punched paper tapes, punched cards, keyboard, etc.
INSTRUCTION	The information which tells a machine where to obtain the operands, what operations to perform, what to do with the result, and sometimes, where to obtain the next instruction.
INTEGER	A whole number.
KEYBOARD BASE REGISTER	Specifies the starting memory location in which succeeding information will be stored.
LABEL	A set of characters identifying an absolute machine address.
LEAST SIGNIFICANT DIGIT POSITION	The 0 position of an Accumulator word or a memory word, if the word is numeric. In an alpha word, the 0 position is the most significant character position.
LEFT JUSTIFY	To position a field to begin at the left-most margin.
LOGIC	A reasonable analysis of the procedures followed in solving a problem.

LOGICAL COMPARISON	The consideration of two things with regard to some characteristic, to obtain a yes if they are the same, or a no if they are different.
LOGICAL OPERATION	A computer operation of comparing, selecting, or taking alternative action.
LOOP	A number of instructions which occur sequentially, a given number of times.
MACHINE LANGUAGE	A code that the computer can recognize and execute.
MACRO INSTRUCTION	A main memory instruction which serves to activate a series of micro instructions contained in firmware.
MAIN MEMORY	1,024 words subdivided into the control area and the normal area.
MASK	A print format for numeric values.
MASK WORD	A word of memory containing mask codes which define print format.
MEMORY LOCATION	A component of the computer in which memory is stored.
MICROSECOND	A millionth of a second (.000001 = ms.)
MILLISECOND	A thousandth of a second (.001 seconds).
MNEMONIC OPERATION CODE	See operation code.
MOST SIGNIFICANT DIGIT POSITION	The highest digit position of an Accumulator word or a memory word, if the word is numeric. In an alpha word, the highest position or the > position is the least significant character position.
MULTIPLICAND	The quantity which is multiplied by each digit of the multiplier in the operation of multiplication.
MULTIPLIER	The operand which controls the repetitive addition of the multiplicand in the operation of multiplication.
NANOSECOND	A billionth of a second.
NEGATIVE VALUE	A value less than zero.
NORMAL AREA	An area in memory used to store the users programs which are written with the macro instructions. It is also used to store constant data, messages, and for accumulating totals.
OBJECT PROGRAM	A program in machine language resulting from the translation of a source program by an assembler.

OPERATION CODE	A symbolic abbreviation for a machine code which controls a computer function.
OUTPUT	The results of computer operations in the form of punched cards, punched paper tape, or printing, etc.
PAPER TAPE	A specially treated strip of paper in which a pattern of holes is punched, which in combination with blank spaces represent numbers and letters.
PAPER TAPE SOURCE PROGRAM	A source program punched on paper tape.
PARAMETER	A quantity which may be assigned different values.
PARITY CHECK	A summation check in which the bits, in a character or word are added and the sum checked against a single previously computed parity digit.
PRINT HEAD	The print ball.
PROGRAM COUNTER	A special register which contains the memory address being executed.
PROGRAM KEY	A key which allows insertion of an arbitrary instruction in the program.
PROGRAM KEY BASE REGISTER	A register containing the first word of the word program key table.
PROGRAM KEY TABLE	An area of memory containing instructions assigned to Program Keys.
POSITIVE VALUE	A value greater than zero.
PSEUDO INSTRUCTION	An instruction designed to provide information to an assembler program.
PUNCH CARD SOURCE PROGRAM	A source program punched on cards.
READ IN	To place data in storage at a specified address.
RIGHT JUSTIFY	To position a field to terminate at the right most margin.
ROUTINE	A set of instructions arranged in proper sequence to cause a machine to perform a desired operation.
SAFEGUARD SYMBOL	Commonly referred to as the dollar sign ($).
SEQUENCE NUMBER	A number identifying the desired order of operations.
SHIFT	To move an ordered set of characters one or more places to the right or left.

SIGNIFICANT DIGIT	Any digit (except a zero in places higher than the highest order non-zero digit) in the expression of a quantity.
SOFTWARE	The material supplied by a computer manufacturer along with the actual equipment (Hardware) i.e., programs, service routines, and operating manuals.
SOURCE PROGRAM	A program written in other than machine language, intended for automatic translation into machine language.
STORE	To transfer information to a place from which the unaltered information can be obtained at a later time.
SYMBOLIC PROGRAM	The use of arbitrary symbols to represent addresses in order to facilitate programing.
TRACK	A track consists of 32 words.
TRANSFER	To convey information from one location to another.
TRANSLATE	To convert information from one language to another without significantly affecting the meaning.
UNPACK	To separate a machine word into parts according to fields of information.
UTILITY PROGRAM	A program which has a use in common to a number of different and unrelated programs, yet is not integral to any program, i.e., trace.
VARIABLE LENGTH FIELD	A field in which the number of characters within the record are not restricted to a given number of positions.
WORD LENGTH	The number of symbols that constitute a word.
WORD NUMBER	A memory address or memory location.
WORD OF MEMORY	16 digits (64 bits) used to store information.
WORKING STORAGE AREA	A portion of storage in which a data item may be processed or temporarily stored. The term often refers to a place in storage used to retain intermediate results of calculations which will not appear as direct output from the program.
ZERO	The integer represented by the character 0, having the property that 0 multiplied by any number and 0 divided by any number is 0.
ZERO SUPPRESSION	The elimination of non-significant zeros to the left of the integral part of a quantity before printing is begun.

GP 300 INSTRUCTIONS TO MACHINE LANGUAGE

Appendix B provides the hexadecimal machine language code for each GP 300 instruction and an alphabetical listing for the GP 300 instruction.

Table B-3 of Appendix B provides hexadecimal values for decimal numbers between 0 and 511.

If a table is not available, the desired value (for values between 0 and 255) may be calculated with the following chart and two simple procedures.

If the value is between 0-15, convert by this chart:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	decimal
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	hexadecimal

1. Decimal to hexadecimal conversion:

   Divide the decimal value by 16.

   Insert the hexadecimal equivalent from above chart as the left most digit of the two digit number.

   Insert the hexadecimal equivalent of the remainder as the right most digit of the two digit number.

   Example: What is the hexadecimal equivalent of the decimal value 255?

   255 ÷ 16 = 15 with 15 remainder

   So 255 must be represented as FF in hexadecimal notation.

2. Hexadecimal to decimal conversion:

   Multiply the decimal equivalent of the left most digit of the two digit hexadecimal number by 16.

   Add the decimal equivalent of the hexadecimal value in the right most position to the previous sum.

   Example: What is the hexadecimal value 2A equivalent to in decimal notation?

   2 x 16 = 32

   A = 10 (see above chart)

   32 + 10 = 42

The machine language code for a GP 300 instruction consists of 4 hexadecimal digits. These digits are identified as Op Code Upper, Op Code Lower, Parameter Upper, and Parameter Lower.

Example:

The machine language code for AL 5 is ED05.

E is the Op Code Upper.

D is the Op Code Lower.

0 is the Parameter Upper.

5 is the Parameter Lower.

In some cases the Op Code Lower is incremented by 1 for word locations above 255 (See Table B-1).

TABLE B-1

INSTRUCTION	MACHINE LANGUAGE CODE				REFERENCE
	OP CODE		PARAMETER		
	UPPER	LOWER	UPPER	LOWER	
ADA	8	8	0-F	0-F	1
ADIR	5	4	0-F	0-F	2
ADK	8	F	0-E	0-9	
ADM	8	0	0-F	0-F	1
AL	E	D	0-F	0-F	
ALARM	0	9	8	0	
ALR	E	F	0-F	0-F	
ALTO	E	9	0-F	1-F	
ALTP	E	5	0	0	
AR	E	E	0-F	0-F	
ARTO	E	A	0-F	1-F	
BRU	7	0	0-F	0-F	3
CC	E	C	0	-	
CDC	B	2	1-F	0-9	
CDV	B	3	1-F	0-9	
CHG	6	6	-	-	5
CLA	8	E	0-E	0-9	
CLM	D	8	0-F	0-F	1
CPA	D	A	0-F	0-F	1
DIR	5	C	0-F	0-F	2
DIV	9	A	0-F	0-F	1
DUP	E	1	0-5	0-F	
EAM	A	9	0-9	0-F	8
EX	4	-	-	-	4,5
EXE	4	-	-	-	4,5
EXL	6	-	0-F	0-F	4
EXZ	4	-	-	-	4,5
IIR	5	8	0-F	0-F	2
INK	9	E	0-E	0-F	
IRCP	1	A	0-F	1-F	
LIR	5	0	0-F	0-F	2
LCD	C	D	0-F	0-F	1
LCFR	D	C	0-F	0-F	
LKBR	F	0	0-F	0-F	2
LLCR	E	0	0-F	0-F	1,10

INSTRUCTION	MACHINE LANGUAGE CODE				REFERENCE
	OP CODE		PARAMETER		
	UPPER	LOWER	UPPER	LOWER	
LLLR	E	4	0-F	0-F	
LOD	6	4	-	-	5
LPF	3	4	A	D	
LPKR	F	C	0-F	0-F	1
LPNR	F	8	0-F	0-F	1
LPR	3	2	4	A	
LRA	3	4	B	1	
LRBR	1	8	0-F	0-F	1
LRCR	E	2	0-F	0-F	
LRLR	E	6	0-F	0-F	
LSA	3	4	B	2	
LSN	3	4	A	7	
LSR	6	4	2	0-F	
LTN	3	4	A	6	
LXC	C	D	0-F	0-F	
MOD	6	0	0	0	2
MUL	8	A	0-F	0-F	1
MULR	8	C	0-F	0-F	1
NK	A	6	0-F	0-F	
NKCM	A	2	0-F	0-F	
NKR	A	4	0-F	0-F	
NKRCM	A	0	0-F	0-F	
NOP	0	8	0	0	
OC	E	8	0-F	0-F	
OFF	0	9	1	0	
PA	C	8	0-F	0-F	2
PAB	1	D	0-9	0-F	8
PBA	B	C	-	-	
PC	C	0	-	-	6
PC+	C	4	-	-	6
PC-	C	5	-	-	6
PCP	C	1	-	-	6
PKA	F	6	0-F	0-F	7
PKB	F	7	0-F	0-F	7
PN	D	4	0-E	0-F	
PNS+	D	0	0-E	0-F	
PNS-	D	1	0-E	0-F	
POS	E	B	0-9	0-F	8

INSTRUCTION	MACHINE LANGUAGE CODE				REFERENCE
	OP CODE		PARAMETER		
	UPPER	LOWER	UPPER	LOWER	
RCD	C	C	0	0	
RCP	1	C	0-F	0-F	
REAM	B	9	0-9	0-F	8
REL	0	1	0	0	
REM	3	A	4	1	
RNK	B	0	0-F	0-F	
RPF	3	C	A	D	
RPR	3	A	8	A	
RR	0	7	0	0	
RRA	3	C	B	1	
RSA	3	C	B	2	
RSN	3	C	A	7	
RST	6	5	-	-	5
RTH	3	C	A	0	
RTK	B	C	0-9	0-F	8
RTKM	B	D	0-9	0-F	8
RTN	3	C	A	6	
RXEAM	B	B	0-9	0-F	8
RXTK	B	E	0-9	0-F	8
RXTKM	B	F	0-9	0-F	8
SCP	1	4	0-F	0-F	
SET	6	7	-	0-F	5
SK	4	-	-	-	4,5
SKE	4	-	-	-	4,5
SKL	6	-	0-F	0-F	4
SKZ	4	-	-	-	4,5
SKP	E	3	0-5	0-F	
SLRO	0	2	0-E	0-E	
SLROS	0	3	0-F	0-F	
SRJ	2	0	0-F	0-F	3
SRR	0	4	0	0-3	9
STOP	0	0	0	0	
SUA	9	8	0-F	0-F	1
SUK	9	F	0-E	0-9	
SUM	9	0	0-F	0-F	1
TAIR	9	C	0	0-3	
TK	A	C	0-9	0-F	8
TKM	A	D	0-9	0-F	8
TRA	3	8	0-15	0-F	1
TRAB	1	5	0	0-F	
TRB	1	E	0	1-F	
TRBA	1	B	0	1-16	
TRCA	B	8	0	0-F	

INSTRUCTION	MACHINE LANGUAGE CODE				REFERENCE
	OP CODE		PARAMETER		
	UPPER	LOWER	UPPER	LOWER	
TRCB	1	6	0-F	0-F	
TRCM	B	9	0	0-F	
TRF	1	7	0-F	0-F	
TRM	3	0	0-F	0-F	
TSB	1	F	0	1-F	
XA	C	6	0-F	0-F	1
XB	0	C	0-F	0-F	
XBA	B	A	-	-	
XC	C	2	-	-	11
XEAM	A	B	0-9	0-F	1,8
XMOD	0	A	0	0	
XN	D	7	0-E	0-F	
XPA	C	A	0-F	0-F	1
XPBA	B	E	-	-	
XPN	D	6	0-E	0-F	
XPNS+	D	2	0-E	0-F	
XPNS-	D	3	0-E	0-F	
XTK	A	E	0-9	0-F	8
XTKM	A	F	0-9	0-F	8

REFERENCES

1. For word number 256-511 add 1 to the Op Code Lower
   9+1=A A+1=B B+1=C C+1=D D+1=E E+1=F
2. Modify Op Code Lower as follows:

INDEX REG. NO.	4	1	2	3
ADD TO OP LOWER	0	1	2	3

3. Modify Op Code Lower as follows:

Syllable	WD. NO.	OP LOWER
0	0-255	0
1	0-255	4
2	0-255	8
3	0-255	C
0	256-511	1
1	256-511	5
2	256-511	9
3	256-511	D

4. Op Code Lower is derived from table below.

INSTRUCTION	NUMBER OF INSTRUCTIONS TO BE EXECUTED OR SKIPPED	OP LOWER
SK or SKZ	4 1 2 3	0 1 2 3
EX or EXZ	4 1 2 3	4 5 6 7
SKE	4 1 2 3	8 9 A B
EXE	4 1 2 3	C D E F
SKL	4 1 2 3	8 9 A B
EXL	4 1 2 3	C D E F

5. Parameter Upper Digit is determined as follows:

FLAG TYPE		PARAMETER UPPER
PUNCH	P	1
READ	R	0
	X	4
	Y	5
TEST	T	8
OCK's	K	9
ACCUM	A	C
Keyboard	B (Buffer)	3
Data Comm	D (Buffer)	A
SKZ		D
EKZ		D

Parameter Lower Digit is determined as follows:

FLAG GROUP			MACHINE LANGUAGE
A	T	P,R,X,Y,K,B,D	CODE VALUE
-	0	4	1
S	L	1	2
C	I	2	4
M	U	3	8

Example: If test flag L is being tested, the lower digit parameter is 2. If test flag L and U are being tested, the lower digit parameter is the sum of the representative code values 2 and 8 = 10. Since the hexadecimal representative of 10 is A, the parameter lower digit is A.

6. PC character codes are determined from Appendix D.
7. Program Key Parameter Designation is determined as follows for Upper and Lower Digit Parameters.

	UPPER				LOWER			
	8	7	6	5	4	3	2	1
PROGRAM KEY								
WEIGHT	8	4	2	1	8	4	2	1

Example: To determine upper and lower parameter values for keys 7 and 4. Key 7 value is 4, key 4 value is 8. The Upper and Lower parameter digits are then 4,8.

Example: To determine Upper and Lower Parameter values for keys 8 and 5. Key 8 value is 8 and 5 value is 1. Both are within the Upper parameter giving an Upper parameter digit of 9 (8 + 1) and Lower parameter digit of 0.

8. PARAMETER LIMIT 0-150
9. SUBROUTINE RETURN LEVEL 1 2 3 4
   MACHINE CODE 0 1 2 3

FOOTNOTE

10. Use upper and lower parameter of 0 (zero) to indicate data communication processor send or receive buffer.
11. Column number (stick number) from USASCII table is upper parameter. Row number (level number) from USASCII table is the lower parameter.

TABLE B-2

MASK WORD

MASK POSITION 0-14

HEX. CODE	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
MASK CHAR.	C	E	S	I	X		Z	D	.C	.D	Z:	D:	.X		Z,	D,

MASK POSITION 15

HEX CODE	0	1	2	3	8	9	A	B
SAFEGUARD	NO	NO	NO	NO	YES	YES	YES	YES
SUPPRESS PUNCTUATION	NO	YES	NO	YES	NO	YES	NO	YES
PUNCH	NO	YES	YES	YES	NO	NO	YES	YES

NUMERIC DATA WORD

The codes for decimal digit are directly equivalent to the Hexadecimal Codes (0-9).

CODES FOR FLAG POSITION 15 OF ACCUMULATOR OR WORD

HEX. CODES	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
FLAGS -	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
S	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
C	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
M	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

1 in the above chart indicates the flag is set.

TABLE B-3
DECIMAL TO HEXADECIMAL CONVERSION TABLE

DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD	
	L	U	L		L	U	L		L	U	L		L	U	L
0	0	0	0	32	0	2	0	64	0	4	0	96	0	6	0
1	0	0	1	33	0	2	1	65	0	4	1	97	0	6	1
2	0	0	2	34	0	2	2	66	0	4	2	98	0	6	2
3	0	0	3	35	0	2	3	67	0	4	3	99	0	6	3
4	0	0	4	36	0	2	4	68	0	4	4	100	0	6	4
5	0	0	5	37	0	2	5	69	0	4	5	101	0	6	5
6	0	0	6	38	0	2	6	70	0	4	6	102	0	6	6
7	0	0	7	39	0	2	7	71	0	4	7	103	0	6	7
8	0	0	8	40	0	2	8	72	0	4	8	104	0	6	8
9	0	0	9	41	0	2	9	73	0	4	9	105	0	6	9
10	0	0	A	42	0	2	A	74	0	4	A	106	0	6	A
11	0	0	B	43	0	2	B	75	0	4	B	107	0	6	B
12	0	0	C	44	0	2	C	76	0	4	C	108	0	6	C
13	0	0	D	45	0	2	D	77	0	4	D	109	0	6	D
14	0	0	E	46	0	2	E	78	0	4	E	110	0	6	E
15	0	0	F	47	0	2	F	79	0	4	F	111	0	6	F
16	0	1	0	48	0	3	0	80	0	5	0	112	0	7	0
17	0	1	1	49	0	3	1	81	0	5	1	113	0	7	1
18	0	1	2	50	0	3	2	82	0	5	2	114	0	7	2
19	0	1	3	51	0	3	3	83	0	5	3	115	0	7	3
20	0	1	4	52	0	3	4	84	0	5	4	116	0	7	4
21	0	1	5	53	0	3	5	85	0	5	5	117	0	7	5
22	0	1	6	54	0	3	6	86	0	5	6	118	0	7	6
23	0	1	7	55	0	3	7	87	0	5	7	119	0	7	7
24	0	1	8	56	0	3	8	88	0	5	8	120	0	7	8
25	0	1	9	57	0	3	9	89	0	5	9	121	0	7	9
26	0	1	A	58	0	3	A	90	0	5	A	122	0	7	A
27	0	1	B	59	0	3	B	91	0	5	B	123	0	7	B
28	0	1	C	60	0	3	C	92	0	5	C	124	0	7	C
29	0	1	D	61	0	3	D	93	0	5	D	125	0	7	D
30	0	1	E	62	0	3	E	94	0	5	E	126	0	7	E
31	0	1	F	63	0	3	F	95	0	5	F	127	0	7	F

DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD	
	L	U	L		L	U	L		L	U	L		L	U	L
128	0	8	0	160	0	A	0	192	0	C	0	224	0	E	0
129	0	8	1	161	0	A	1	193	0	C	1	225	0	E	1
130	0	8	2	162	0	A	2	194	0	C	2	226	0	E	2
131	0	8	3	163	0	A	3	195	0	C	3	227	0	E	3
132	0	8	4	164	0	A	4	196	0	C	4	228	0	E	4
133	0	8	5	165	0	A	5	197	0	C	5	229	0	E	5
134	0	8	6	166	0	A	6	198	0	C	6	230	0	E	6
135	0	8	7	167	0	A	7	199	0	C	7	231	0	E	7
136	0	8	8	168	0	A	8	200	0	C	8	232	0	E	8
137	0	8	9	169	0	A	9	201	0	C	9	233	0	E	9
138	0	8	A	170	0	A	A	202	0	C	A	234	0	E	A
139	0	8	B	171	0	A	B	203	0	C	B	235	0	E	B
140	0	8	C	172	0	A	C	204	0	C	C	236	0	E	C
141	0	8	D	173	0	A	D	205	0	C	D	237	0	E	D
142	0	8	E	174	0	A	E	206	0	C	E	238	0	E	E
143	0	8	F	175	0	A	F	207	0	C	F	239	0	E	F
144	0	9	0	176	0	B	0	208	0	D	0	240	0	F	0
145	0	9	1	177	0	B	1	209	0	D	1	241	0	F	1
146	0	9	2	178	0	B	2	210	0	D	2	242	0	F	2
147	0	9	3	179	0	B	3	211	0	D	3	243	0	F	3
148	0	9	4	180	0	B	4	212	0	D	4	244	0	F	4
149	0	9	5	181	0	B	5	213	0	D	5	245	0	F	5
150	0	9	6	182	0	B	6	214	0	D	6	246	0	F	6
151	0	9	7	183	0	B	7	215	0	D	7	247	0	F	7
152	0	9	8	184	0	B	8	216	0	D	8	248	0	F	8
153	0	9	9	185	0	B	9	217	0	D	9	249	0	F	9
154	0	9	A	186	0	B	A	218	0	D	A	250	0	F	A
155	0	9	B	187	0	B	B	219	0	D	B	251	0	F	B
156	0	9	C	188	0	B	C	220	0	D	C	252	0	F	C
157	0	9	D	189	0	B	D	221	0	D	D	253	0	F	D
158	0	9	E	190	0	B	E	222	0	D	E	254	0	F	E
159	0	9	F	191	0	B	F	223	0	D	F	255	0	F	F

DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD	
	L	U	L		L	U	L		L	U	L		L	U	L
256	1	0	0	288	1	2	0	320	1	4	0	352	1	6	0
257	1	0	1	289	1	2	1	321	1	4	1	353	1	6	1
258	1	0	2	290	1	2	2	322	1	4	2	354	1	6	2
259	1	0	3	291	1	2	3	323	1	4	3	355	1	6	3
260	1	0	4	292	1	2	4	324	1	4	4	356	1	6	4
261	1	0	5	293	1	2	5	325	1	4	5	357	1	6	5
262	1	0	6	294	1	2	6	326	1	4	6	358	1	6	6
263	1	0	7	295	1	2	7	327	1	4	7	359	1	6	7
264	1	0	8	296	1	2	8	328	1	4	8	360	1	6	8
265	1	0	9	297	1	2	9	329	1	4	9	361	1	6	9
266	1	0	A	298	1	2	A	330	1	4	A	362	1	6	A
267	1	0	B	299	1	2	B	331	1	4	B	363	1	6	B
268	1	0	C	300	1	2	C	332	1	4	C	364	1	6	C
269	1	0	D	301	1	2	D	333	1	4	D	365	1	6	D
270	1	0	E	302	1	2	E	334	1	4	E	366	1	6	E
271	1	0	F	303	1	2	F	335	1	4	F	367	1	6	F
272	1	1	0	304	1	3	0	336	1	5	0	368	1	7	0
273	1	1	1	305	1	3	1	337	1	5	1	369	1	7	1
274	1	1	2	306	1	3	2	338	1	5	2	370	1	7	2
275	1	1	3	307	1	3	3	339	1	5	3	371	1	7	3
276	1	1	4	308	1	3	4	340	1	5	4	372	1	7	4
277	1	1	5	309	1	3	5	341	1	5	5	373	1	7	5
278	1	1	6	310	1	3	6	342	1	5	6	374	1	7	6
279	1	1	7	311	1	3	7	343	1	5	7	375	1	7	7
280	1	1	8	312	1	3	8	344	1	5	8	376	1	7	8
281	1	1	9	313	1	3	9	345	1	5	9	377	1	7	9
282	1	1	A	314	1	3	A	346	1	5	A	378	1	7	A
283	1	1	B	315	1	3	B	347	1	5	B	379	1	7	B
284	1	1	C	316	1	3	C	348	1	5	C	380	1	7	C
285	1	1	D	317	1	3	D	349	1	5	D	381	1	7	D
286	1	1	E	318	1	3	E	350	1	5	E	382	1	7	E
287	1	1	F	319	1	3	F	351	1	5	F	383	1	7	F

DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD		DEC. EQUIV.	OP. FIELD	PARAMETER FIELD	
	L	U	L		L	U	L		L	U	L		L	U	L
384	1	8	0	416	1	A	0	448	1	C	0	480	1	E	0
385	1	8	1	417	1	A	1	449	1	C	1	481	1	E	1
386	1	8	2	418	1	A	2	450	1	C	2	482	1	E	2
387	1	8	3	419	1	A	3	451	1	C	3	483	1	E	3
388	1	8	4	420	1	A	4	452	1	C	4	484	1	E	4
389	1	8	5	421	1	A	5	453	1	C	5	485	1	E	5
390	1	8	6	422	1	A	6	454	1	C	6	486	1	E	6
391	1	8	7	423	1	A	7	455	1	C	7	487	1	E	7
392	1	8	8	424	1	A	8	456	1	C	8	488	1	E	8
393	1	8	9	425	1	A	9	457	1	C	9	489	1	E	9
394	1	8	A	426	1	A	A	458	1	C	A	490	1	E	A
395	1	8	B	427	1	A	B	459	1	C	B	491	1	E	B
396	1	8	C	428	1	A	C	460	1	C	C	492	1	E	C
397	1	8	D	429	1	A	D	461	1	C	D	493	1	E	D
398	1	8	E	430	1	A	E	462	1	C	E	494	1	E	E
399	1	8	F	431	1	A	F	463	1	C	F	495	1	E	F
400	1	9	0	432	1	B	0	464	1	D	0	496	1	F	0
401	1	9	1	433	1	B	1	465	1	D	1	497	1	F	1
402	1	9	2	434	1	B	2	466	1	D	2	498	1	F	2
403	1	9	3	435	1	B	3	467	1	D	3	499	1	F	3
404	1	9	4	436	1	B	4	468	1	D	4	500	1	F	4
405	1	9	5	437	1	B	5	469	1	D	5	501	1	F	5
406	1	9	6	438	1	B	6	470	1	D	6	502	1	F	6
407	1	9	7	439	1	B	7	471	1	D	7	503	1	F	7
408	1	9	8	440	1	B	8	472	1	D	8	504	1	F	8
409	1	9	9	441	1	B	9	473	1	D	9	505	1	F	9
410	1	9	A	442	1	B	A	474	1	D	A	506	1	F	A
411	1	9	B	443	1	B	B	475	1	D	B	507	1	F	B
412	1	9	C	444	1	B	C	476	1	D	C	508	1	F	C
413	1	9	D	445	1	B	D	477	1	D	D	509	1	F	D
414	1	9	E	446	1	B	E	478	1	D	E	510	1	F	E
415	1	9	F	447	1	B	F	479	1	D	F	511	1	F	F

INSTRUCTION	OP CODE	A	B	C
Add to Accumulator	ADA	LABEL		
Add to Index Register	ADIR	1-4	0-255	
Add Constant to Accumulator	ADK	0-14	0-9	
Add to Memory	ADM	LABEL		
Advance Left Platen	AL	0-255		
Alarm	ALARM			
Advance both platens	ALR	0-255		
Advance left platen to	ALTO	1-255		
Select Alternate Stacker	ALTP			
Advance right platen	AR	0-255		
Advance right platen to	ARTO	1-255		
Branch unconditionally	BRU	LABEL		
Close forms transport	CC			
Check Digit Compute	CDC	1-15	0-9	
Check Digit Verify	CDV	1-15	0-9	
Change Flags	CHG	A,K,R,P, X,Y	1,2,3,4,-, S,C,M	
Clear Accumulator and insert constant	CLA	0-15	0-15	
Clear Memory Word	CLM	LABEL		
Compare alphanumeric	CPA	LABEL		
Decrement Index Register	DIR	1-4	0-255	
Divide	DIV	LABEL		
Duplicate thru column	DUP	1-80		
Enter Alpha into Memory	EAM	LABEL		
Execute if any Flag	EX	A,T,K,P, R,X,Y	-SCM 1234OLIU	1-4 1-4
Execute if every Flag	EXE			
Execute if digit less than constant	EXL	0-15	0-15	1-4
Execute if Accumulator zero	EXZ	1-4		
Increment Index Register	IIR	1-4	0-255	
Insert Constant in Accumulator	INK	0-15	0-15	
Load Index Register	LIR	1-4	0-255	
Load Memory from Card	LCD	0-255		
Load Card Format Register	LCFR	LABEL		
Load Keyboard Base Register	LKBR	LABEL		
Load Left Count Register	LLCR	0-255		
Load Left Limit Register	LLLR	0-255		
Load Flags	LOD	A,K,R,P, X,Y	1,2,3,4,-, S,C,M	
Load Program Key Base Register	LPKR	LABEL		
Load Print Numeric Base Register	LPNR	LABEL		
Load Right Count Register	LRCR	0-255		
Load Right Limit Register	LRLR	0-255		
Load Shift Register	LSR	0-15		

INSTRUCTION	OP CODE	A	B	C
Load Punch Count Register	LXC	1		
Load Punch Count Register	LXC	0-255		
Modify by Index Register	MOD	1-4		
Multiply	MUL	LABEL		
Multiply and Round	MULR	LABEL		
Numeric Keyboard	NK	0-15	0-15	
Numeric Keyboard Permit C, M Keys	NKCM	0-15	0-15	
Numeric Keyboard Permit Reverse Entry	NKR	0-15	0-15	
Numeric Keyboard Permit Reverse Entry, C, M Keys	NKRCM	0-15	0-15	
No-Operation	NOP			
Open forms transport	OC	0-255		
Print Alphanumeric	PA	LABEL		
Print Character	PC	CHARACTER		
Print Character if Accumulator plus, Previous Ribbon	PC+	CHARACTER		
Print Character if Accumulator minus, Previous Ribbon	PC-	CHARACTER		
Print Character Previous Ribbon	PCP	CHARACTER		
Enable Program Key Group A	PKA	1-8		
Enable Program Key Group B	PKB	1-8		
Enable Program Key Group C	PKC	1-8		
Print Numeric	PN	0-14	0-15	
Print Numeric Shift Ribbon if plus	PNS+	0-14	0-15	
Print Numeric Shift Ribbon if minus	PNS-	0-14	0-15	
Load Position Register	POS	1-255		
Read Card	RCD			
Enter Alpha into memory, punch non-print	REAM	0-150		
Release Media Clamp	REL			
Transfer Remainder to Accumulator	REM			
Read Numeric into Accumulator	RNK	0-15	0-15	
Red Ribbon	RR			
Reset Flags	RST	A, K,R,P, X,Y	1,2,3,4,-, S,C,M	
Read Alpha and Print	RTK	0-255		
Read Alpha into Memory and Punch, non-print	RXEAM	0-255		
Read Alpha, print and punch	RXTK	0-255		
Read Alpha into memory, print and punch	RXTKM	0-255		
Set Flags	SET	A,K,R,P, X,Y	1,2,3,4,-, S,C,M	
Skip if any Flag	SK	A,K,R,P X,Y	1,2,3,4,-, S,C,M O,C,I,U	1-4

INSTRUCTION	OP CODE	A	B	C
Skip if every Flag	SKE	A,K,R,P, X,Y	1,2,3,4,-, S,C,M O,C,I,U	1-4
Skip if digit less than Constant	SKL	0-15	0-15	1-4
Skip to card column	SKP	1-80		
Skip if Accumulator Zero	SKZ	1-4		
Shift Off	SLRO	0-14	0-14	
Shift Off with Sign	SLROS	0-15	0-15	
Subroutine Jump	SRJ	LABEL		
Subroutine Return	SRR	1-4		
Stop	STOP			
Subtract from Accumulator	SUA	LABEL		
Subtract Constant from Accumulator	SUK	0-14	0-9	
Subtract from Memory	SUM	LABEL		
Transfer Accumulator to Index Register	TAIR	1-4		
Type	TK	0-255		
Type into Memory	TKM	0-255		
Transfer to Accumulator	TRA	LABEL		
Transfer Card Field to Accumulator as Numeric	TRCA	1-16		
Transfer Card Column to Memory as Alpha	TRCM	1-16		
Transfer to Memory	TRM	LABEL		
Punch Alpha from Memory, Non-Print	XA	LABEL		
Punch Feed Codes	XB	0-255		
Punch Alpha from Card Read Area, Non-Print	XBA	1-16		
Punch Code	XC	0-15	0-15	
Enter Alpha into Memory and Punch, Non-Print	XEAM	LABEL		
Modify by Punch Count Register	XMOD			
Punch Numeric, Non-Print	XN	0-14	0-15	
Print Alpha and Punch	XPA	LABEL		
Print and Punch Alpha from Card Read Area	XPBA	1-16		
Print and Punch Numeric	XPN	0-14	0-15	
Print and Punch Numeric Shift Ribbon if Plus	XPNS+	0-14	0-15	
Print and Punch Numeric Shift Ribbon if Minus	XPNS-	0-14	0-15	
Type Punch and Print	XTK	0-255		
Type to Memory Punch and Print	XTKM	0-255		

DATA COMMUNICATION INSTRUCTIONS

INSTRUCTIONS	OP CODE	A	B	C
Change Flags	CHG	R	23	
Execute if any Flag	EX	RBD	1234	1-4
Execute if every Flag	EXE	RBD	1234	1-4
Increment Receive Character Pointer	IRCP	0-255		
Load Flags	LOD	R	23	
Load Polled Flags Register	LPF	-		
Load Receive Address Register	LRA	-		
Load Receive Buffer Register	LRBR	LABEL or BLANK		
Load Send Address Register	LSA	-		
Load Send Transmission Number	LSN	-		
Load Expected Transmission Number Register	LTN	-		
Power Off	OFF			
Print Alpha from Receive Buffer	PAB	0-150		
Set Receive Character Pointer	RCP	1-255		
Retrieve Polled Flags	RPF	-		
Retrieve Character Pointer Register	RPR	-		
Retrieve Receive Address	RRA	-		
Retrieve Send Address	RSA	-		
Retrieve Send Transmission Number	RSN	-		
Reset Flags	RST			
Retrieve Header Transmission Number	RTH	-		
Retrieve Expected Transmission Number	RTN	-		
Set Send Character Pointer	SCP	1-255		
Set Flags	SET	R	23	
Skip if Flag	SK	RBD	1234	1-4
Skip if every Flag	SKE	RBD	1234	1-4
Transfer Accumulator to Send Record Area	TRAB	0-15	0 or 1	
Transfer Receive Buffer	TRB	LABEL		
Transfer to Accumulator as Numeric	TRBA	0-16		
Transfer Character	TRCB	0-15	0-15	
Transfer Alpha	TRF	0-255		
Transfer Send Record Area	TSB	LABEL		

ASSEMBLER PSEUDO INSTRUCTIONS

OP CODE	A	B	FUNCTION	PAGE REFERENCE
ADVL	1-4		To space the Assembler output form the number of lines specified in the A parameter.	2-112
ALF			To store alphanumeric constants.	2-112
CDB			To reserve words 1-10 as card read-in buffer, automatic branch to word 11, syllable 0.	2-113
CDF	1-80	1-80	A parameter indicates the beginning card column of a field, B parameter defines the number of card columns in the field.	2-115
CODE	4 hexa-decimal digits		To allow insertion of 4 hexadecimal digits into a syllable of memory.	2-115
DEF	O-N *		To assign a value to a label.	2-116
DEFT	0-15	0-15	To assign a value to a label in both A and B fields.	2-116
DOC			For documentation when assembling on B 2500, B 3500, B 5500 49 characters beginning in column 29.	2-117
END			To terminate the Assembler program, the last line of code in the program.	2-118
EQU			To equate the label in label field to the label in the A parameter.	2-118
ESTB			To reserve 32 words in high order memory for receive, send buffer.	2-117
MASK			Allow entry of mask word 24 print format characters are accepted.	2-119
NOTE			For documentation will allow entry of 25 characters, beginning in column 53.	2-119
NUM			To store numeric constants.	2-120
ORG	O-N**		To assemble the instruction following ORG in the word location specified in the A parameter.	2-120

OP CODE	A	B	FUNCTION	PAGE REFERENCE
PAGE			To space Assembler output to the first line of the next page.	2-121
REG	1-255		To reserve the number of words specified in the A parameter for working-storage.	2-121
WORD			To cause the Assembler to assign the next instruction in syllable O of the next word.	2-122

***The upper limit is variable depending upon which Operation Code the label will be used.**

****The upper limit is variable depending upon the amount of user memory.**

SERIES L/TC CHARACTER SETS

The USASCII and Commercial character sets for the Series L/TC Systems are listed below in their collating sequence in ascending order. Each character set consists of 64 graphic characters, the Space code, and the End of Alpha code. The USASCII character set consists of the USASCII characters in columns 2, 3, 4, and 5 of the USASCII table, plus End of Alpha (NUL) and Overline. Those Commercial characters that differ from the USASCII characters are shown in parentheses.

The internal or machine language code for each character is given; this code consists of two hexadecimal digits which correspond to the column and row number of the character in the USASCII table (A=row 10, B=11, C=12, D=13, E=14, F=15). In addition, the decimal value of each character is given as required when using Index Registers for modification.

Character	Internal Code	Indexing Value	Character	Internal Code	Indexing Value	Character	Internal Code	Indexing Value	Character	Internal Code	Indexing Value
End of Alpha (NUL)	0 0	0									
Space	2 0	32	0	3 0	48	@	4 0	64	P	5 0	80
!	2 1	33	1	3 1	49	A	4 1	65	Q	5 1	81
"	2 2	34	2	3 2	50	B	4 2	66	R	5 2	82
#	2 3	35	3	3 3	51	C	4 3	67	S	5 3	83
$	2 4	36	4	3 4	52	D	4 4	68	T	5 4	84
%	2 5	37	5	3 5	53	E	4 5	69	U	5 5	85
&	2 6	38	6	3 6	54	F	4 6	70	V	5 6	86
'	2 7	39	7	3 7	55	G	4 7	71	W	5 7	87
(	2 8	40	8	3 8	56	H	4 8	72	X	5 8	88
)	2 9	41	9	3 9	57	I	4 9	73	Y	5 9	89
*	2 A	42	:	3 A	58	J	4 A	74	Z	5 A	90
+	2 B	43	;	3 B	59	K	4 B	75	[(¾)	5 B	91
,	2 C	44	< (½)	3 C	60	L	4 C	76	\ (¢)	5 C	92
-	2 D	45	=	3 D	61	M	4 D	77	](CR)	5 D	93
.	2 E	46	> (¼)	3 E	62	N	4 E	78	^ (°)	5 E	94
/	2 F	47	?	3 F	63	O	4 F	79	_	5 F	95
									~ (<>)	7 E	126
									DEL	7 F	127

TABLES OF MASK CODES

TABLE E-1 MASK CONTROL CODES

CONTROL CODES	PRINT FUNCTION	PUNCH FUNCTION
F	Print $	No effect
+	Suppress Punctuation	No effect
P	No effect	Leading zeros punch in P flag set blank card column in 80 column card if P flag reset.

TABLE E-2 MASK FLAG CODES

FLAG CODES	PRINT FUNCTION	PUNCH FUNCTION
D	Print digit regardless of significance.	Punch character regardless of significance.
D,	Print digit and comma regardless of significance.	
.D	Print decimal point and digit regardless of significance.	
D:	Print digit and decimal point regardless of significance.	
X	Suppress Terminal Zeros	
.X	Decimal point and terminal zero suppression.	
C	Units of cents leading and terminal zero suppress.	
.C	Tenths of cents decimal point with leading and terminal zero suppression.	
Z	Leading zero suppression.	Punch if: 1. P is set. 2. Accumulator digit not zero. 3. A non-zero digit has been punched.
Z,	Leading zero suppression and comma.	
Z:	Leading zero suppression and decimal point.	

FLAG CODES	PRINT FUNCTION	PUNCH FUNCTION
S	Print only if Accumulator digit non-zero.	
I	Ignore digit	Ignore
E	Terminate, non-print	Terminate, non-print

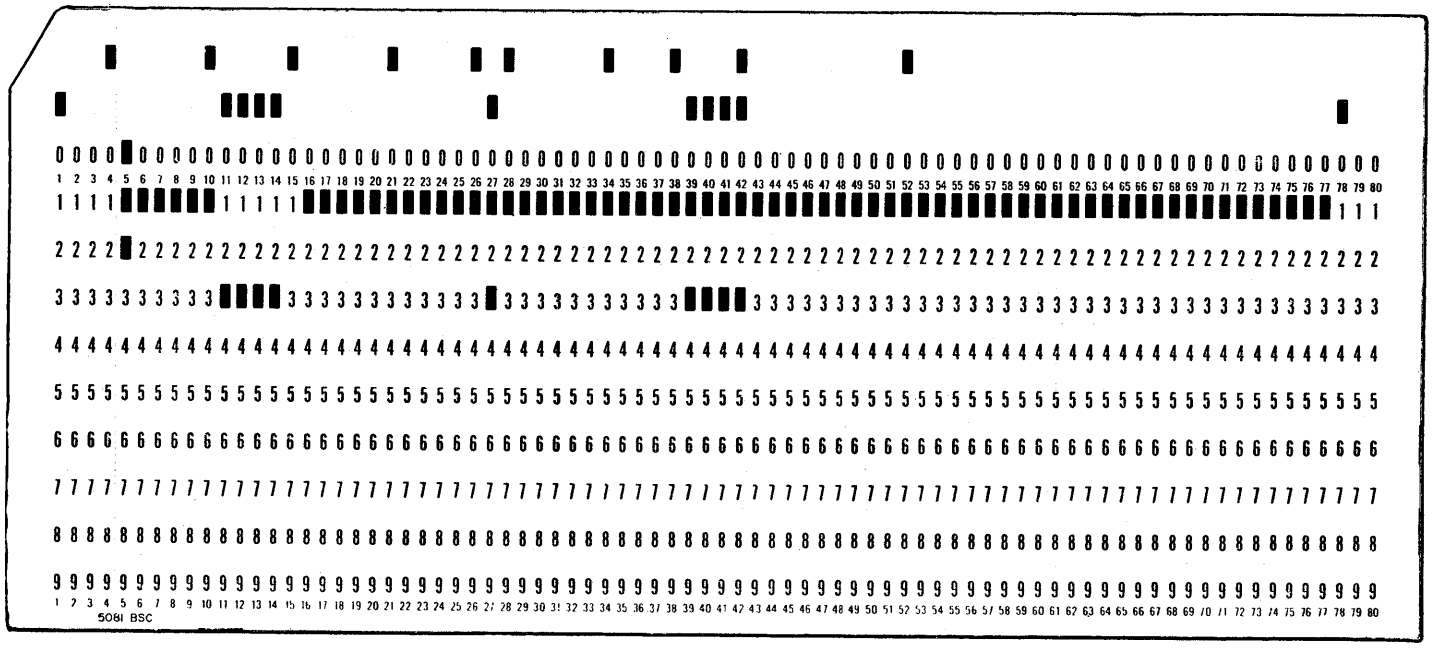
ERROR MESSAGES

MESSAGE	PAGE REFERENCE
INSTR LABEL DUPLICATED	5-47
INSTR LABEL INVALID	5-47
INVALID CHARACTER	5-49
INVALID CTL CARD	5-46
INVALID FLD LENGTH	5-47
INVALID INCREMENT FLD	5-48
INVALID MNEMONIC	5-48
INVALID SIGN RESULT	5-48
LABEL LIMIT	5-47
LAST LINE NOT "END"	5-49
MEMORY 512	5-49
MEMORY OVERLAYED ERR	5-49
MUST HAVE LBL OR INC	5-48
NO I/P CTL	5-46
NO O/P SYM	5-47
NO OBJECT	5-46
NOP INSERTED	5-46
. . . PARAMETER INVALID X	5-48
. . . PARAMETER INVALID RANGE XXX-XXX	5-48
PRE INV FLD LENGTH	5-47
SEQUENCE	5-46
STORAGE EXCEEDED	5-49
WORD LENGTH EXCEEDED	5-49

INSTRUCTIONS FOR KEYPUNCHING SYMBOLIC CARDS

SYMBOLIC CARD FORMAT

CARD COLUMNS	DESCRIPTION
5 - 10	Program ID
11 - 15	Sequence
16 - 21	Label
22 - 26	Op Code
27 - 28	Field Length
29 - 34	Label "A" Parameter
29 - 47	Constant Data (Numeric)
29 - 52	Alphanumeric Data or Print Mask
35 - 38	+ or – inc/rel
39 - 42	"B" Parameter
43	"C" Parameter
55 - 77	Remarks



Drum Card for Burroughs A 142/A 150 Keypunch

A 142/A 150 KEYPUNCHING INSTRUCTIONS

1. Insert drum card – position 1.
2. Lower drum card brushes.
3. Turn Power switch ON.
4. Turn PRINTER switch ON.
5. Turn AUTO FEED switch ON.
6. Turn Program switch 1 (P1) ON.
7. First card stops in CC 5. ERR REL light turns on. Depress ERR REL switch.
8. Must punch Program I.D. CC 5-10 in 1st card*. Thereafter, CC 5-10 will automatically duplicate.
9. CC 11-15. Sequence Number – numeric (right justified).
10. CC 16-21. Label. If no Label, depress SKIP key.
11. CC 22-26. Op Code. If OP CODE less than 5 characters, depress SKIP key.
12. CC 27-28. Field Length (right justified). If no field length, depress SKIP key.
13. CC 29-34. "A" Parameter. If less than 5 characters, depress SKIP key. If numeric, hold NUMERIC key down while punching numeric character.
14. CC 35-38. + or – Increment field. If –, enter – in CC 35 (if CC 35 is blank, + is assumed). Enter numeric in CC 36-38. If no + or – Increment, depress SKIP key.
15. CC 39-42. "B" Parameter. If numeric, hold NUMERIC key down while punching numeric character. If no "B" parameter, depress SKIP key.
16. CC 43. "C" Parameter. Numeric only. If no "C" parameter, depress SKIP key.
17. CC 53-77. Remarks columns – alphanumeric. If no Remarks, depress SKIP or REL key.
18. When numeric is to be punched, other than sequence field, hold numeric key down while punching that field.

***If Program I.D. is not required, the user may modify the existing drum card thusly:**

1. **Eliminate the 2 punch in card column 5. This will allow the detail card to duplicate blank columns 5 through 10.**

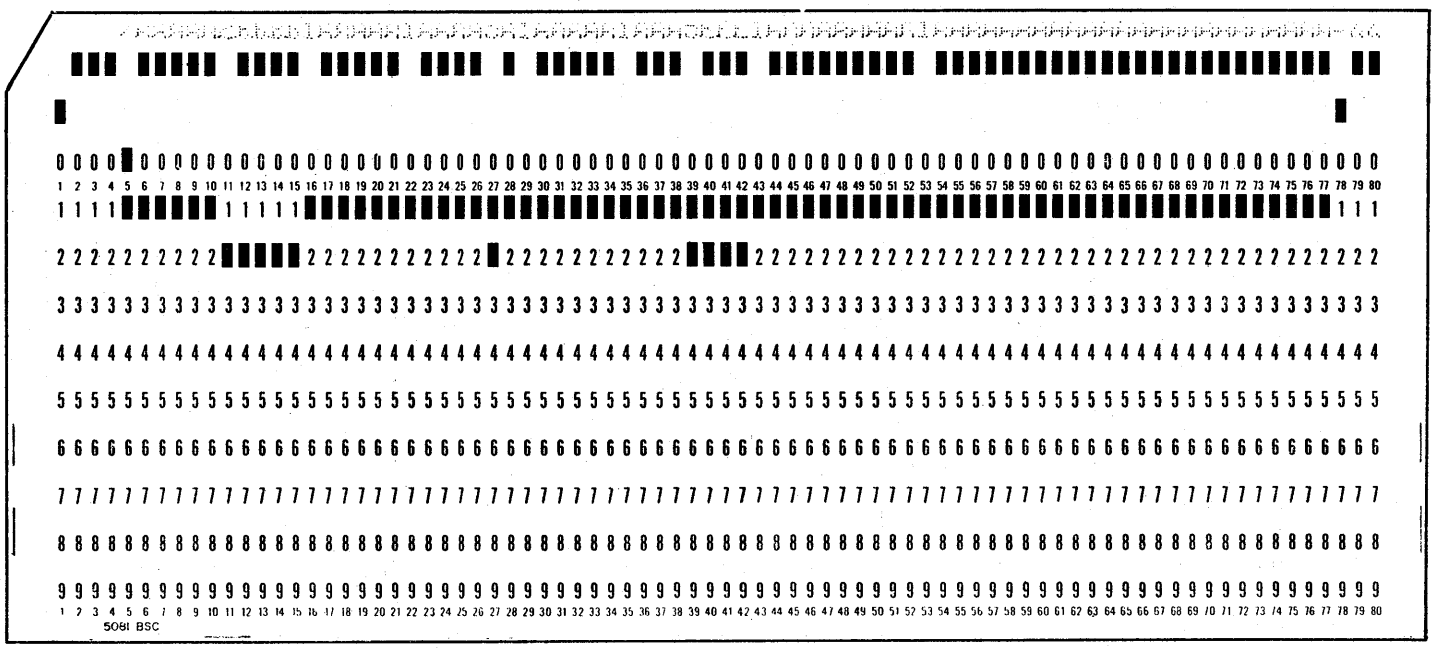
   or

2. **Eliminate the 12 punch in card column 4. This will allow a skip over columns 5-10.**

024/026/029 KEYPUNCHING INSTRUCTIONS

1. Insert front drum card – star wheels down.
2. Turn Power switch ON.
3. Turn PRINT switch ON.
4. Turn AUTO DUP-AUTO SKIP switch OFF - first card only.
5. Must punch Program I.D. CC 5-10*. Turn on AUTO DUP-AUTO SKIP after punch of sequence field, so that CC 5-10 will automatically duplicate on all subsequent cards.
6. CC 11-15. Sequence Number – numeric (right justified).
7. CC 16-21. Label. If no Label, depress SKIP key.
8. CC 22-26. Op Code. If OP CODE less than 5 characters, depress SKIP key.
9. CC 27-28. Field Length (right justified). If no field length, depress SKIP key.
10. CC 29-34. "A" Parameter. If less than 5 characters, depress SKIP key. If numeric, hold NUMERIC key down while punching numeric character.
11. CC 35-38. + or – Increment field. If –, enter – in CC 35 (if CC 35 is blank, + is assumed). Enter numeric in CC 36-38. If no + or – Increment, depress SKIP key.
12. CC 39-42. "B" Parameter. If numeric, hold NUMERIC key down while punching numeric character. If no "B" parameter, depress SKIP key.
13. CC 43. "C" Parameter. Numeric only. If no "C" parameter, depress SKIP key.
14. CC 53-77. Remarks columns – alphanumeric. If no Remarks, depress SKIP or REL key.
15. Whenever numeric punching is required, other than sequence field, numeric key must be held down while punching that field.

*** If Program I.D. is not required in detail card, insert a "12" punch in CC 5 of program card. This will allow skip CC 5 through 10 in detail card. AUTO DUP/AUTO SKIP key can be turned on from the very first card.**



Front Drum Card for 024/026/029

USASCII CHART AND CHARACTER SETS

Bits b_4	b_3	b_2	b_1	Row \ Column	0 (000)	1 (001)	2 (010)	3 (011)	4 (100)	5 (101)	6 (110)	7 (111)
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	¦
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	—	o	DEL

USA Standard Code for Information Interchange

USASCII						EBCDIC			BCL			80 COL CARD INTRNL BUFFER		PAPER TAPE CODE	
USASCII CHAR	INTRNL CODE UP	INTRNL CODE LOW	L/TC GRAPHIC	PAPER TAPE CODE	INDEX REG VALUE	GRAPHIC CHAR	CARD CODE	KEY	GRAPHIC CHAR	CARD CODE	KEY	UP	LOW	UP	LOW
NUL	0	0			0	NUL	12 - 0 - 9 - 8 - 1	M						0	0
SOH	0	1			1	SOH	12 - 9 - 1	M						8	1
STX	0	2			2	STX	12 - 9 - 2	M						8	2
ETX	0	3			3	ETX	12 - 9 - 3	M						0	3
EOT	0	4			4	EOT	9 - 7	M						8	4
ENQ	0	5			5	ENQ	0 - 9 - 8-5	M						0	5
ACK	0	6			6	ACK	0 - 9 - 8-6	M						0	6
BEL	0	7			7	BEL	0 - 9 - 8-7	M						8	7
BS	0	8			8	BS	11 - 9 - 6	M						8	8
HT	0	9			9	HT	12 - 9 - 5	M						0	9
IF	0	A			10	IF	0 - 9 - 5	M						0	A
VT	0	B			11	VT	12 - 9 - 8-3	M						8	B
FF	0	C			12	FF	12 - 9 - 8-4	M						0	C
CR	0	D			13	CR	12 - 9 - 8-5	M						8	D
SO	0	E			14	SO	12 - 9 - 8-6	M						8	E
SI	0	F			15	SI	12 - 9 - 8-7	M						0	F
DLE	1	0			16	DLE	12 - 11 - 9 - 8 - 1	M						9	0
DC1	1	1			17	DC1	11 - - 9 - 1	M						1	1
DC2	1	2			18	DC2	11 - - 9 - 2	M						1	2
DC3	1	3			19	DC3	11 - 9 - 3	M						9	3
DC4	1	4			20	DC4	9 - 8 - 4	M						1	4
NAK	1	5			21	NAK	9 - 8 - 5	M						9	5
SYN	1	6			22	SYN	9 - 2	M						9	6
ETB	1	7			23	ETB	0 - 9 - 6	M						1	7
CAN	1	8			24	CAN	11 - 9 - 8	M						1	8
EM	1	9			25	EM	11 - 9 - 8 - 1	M						9	9
SUB	1	A			26	SUB	9 - 8 - 7	M						9	A
ESC	1	B			27	ESC	0 - 9 - 7	M						1	B
FS	1	C			28	FS	11 - 9 - 8 - 4	M						9	C
GS	1	D			29	GS	11 - 9 - 8 - 5	M						1	D
RS	1	E			30	RS	11 - 9 - 8 - 6	M						1	E
US	1	F			31	US	11 - 9 - 8 - 7	M						9	F

Key: M Multipunch on 026, 029, A 142, and A 150

USASCII						EBCDIC			BCL			BUFFER		TAPE	
USASCII CHAR	INTRNL CODE UP	INTRNL CODE LOW	L/TC GRAPHIC	PAPER TAPE CODE	INDEX REG VALUE	GRAPHIC CHAR	CARD CODE	KEY	GRAPHIC CHAR	CARD CODE	KEY	UP	LOW	UP	LOW
SP	2	0	SP		32	SP	BLANK	*	SP	BLANK	*	0	0	A	0
!	2	1	!		33	!	11-0	I	X	11-0	M	6	0	2	1
"	2	2	"		34	"	8-7	#	"	0-8-7	M	2	F	2	2
#	2	3	#		35	#	8-3	*	#	8-3	*	0	B	A	3
$	2	4	$		36	$	11-8-3	*	$	11-8-3	*	4	B	2	4
%	2	5	%		37	%	0-8-4	*	%	0-8-4	*	2	C	A	5
&	2	6	&		38	&	12	*	&	12	*	8	0	A	6
'	2	7	'		39	'	8-5	#	⩾	8-7	M	0	F	2	7
(	2	8	(		40	(	12-8-5	#	(	12-8-5	#	8	D	2	8
)	2	9	)		41	)	11-8-5	#	)	11-8-5	#	4	D	A	9
*	2	A	*		42	*	11-8-4	*	*	11-8-4	*	4	C	A	A
+	2	B	+		43	+	12-0	I	+	12-0	I	A	0	2	B
,	2	C	,		44	,	0-8-3	*	,	0-8-3	*	2	B	A	C
-	2	D	-		45	-	11	*	-	11	*	4	0	2	D
.	2	E	.		46	.	12-8-3	*	.	12-8-3	*	8	B	2	E
/	2	F	/		47	/	0-1	*	/	0-1	*	2	1	A	F
0	3	0	0		48	0	0	*	0	0	*	2	0	3	0
1	3	1	1		49	1	1	*	1	1	*	0	1	B	1
2	3	2	2		50	2	2	*	2	2	*	0	2	B	2
3	3	3	3		51	3	3	*	3	3	*	0	3	3	3
4	3	4	4		52	4	4	*	4	4	*	0	4	B	4
5	3	5	5		53	5	5	*	5	5	*	0	5	3	5
6	3	6	6		54	6	6	*	6	6	*	0	6	3	6
7	3	7	7		55	7	7	*	7	7	*	0	7	B	7
8	3	8	8		56	8	8	*	8	8	*	0	8	B	8
9	3	9	9		57	9	9	*	9	9	*	1	0	3	9
:	3	A	:		58	:	8-2	#	:	8-5	M	0	D	3	A
;	3	B	;		59	;	11-8-6	#	;	11-8-6	#	4	E	B	B
<	3	C	< or ¼		60	<	12-8-4	#	<	12-8-6	M	8	E	3	C
=	3	D	=		61	=	8-6	#	=	0-8-5	M	2	D	B	D
>	3	E	> or ¼		62	>	0-8-6	#	>	8-6	M	0	E	B	E
?	3	F	?		63	?	0-8-7	#	?	ALL OTHER	M			3	F

Key: * Keys on 026, 029, A 142 and A 150 Punch Correct Code.
M Multipunch on 026, 029, A 142 and A 150.
Keys on 029, and A 150 punch correct code; multipunch on 026 and A 142.
I Keys on 029 and A 150 punch invalid code; multipunch on 026, 029, A 142 and A 150.

USASCII						EBCDIC			BCL			BUFFER		TAPE	
USASCII CHAR	INTRNL CODE UP	INTRNL CODE LOW	L/TC GRAPHIC	PAPER TAPE CODE	INDEX REG VALUE	GRAPHIC CHAR	CARD CODE	KEY	GRAPHIC CHAR	CARD CODE	KEY	UP	LOW	UP	LOW
@	4	0	@	●● ●	64	@	8-4	*	@	8-4	*	0	C	C	0
A	4	1	A	● ●	65	A	12-1	*	A	12-1	*	8	1	4	1
B	4	2	B	● ●	66	B	12-2	*	B	12-2	*	8	2	4	2
C	4	3	C	●● ● ●●	67	C	12-3	*	C	12-3	*	8	3	C	3
D	4	4	D	● ●	68	D	12-4	*	D	12-4	*	8	4	4	4
E	4	5	E	●● ● ●	69	E	12-5	*	E	12-5	*	8	5	C	5
F	4	6	F	●● ●●	70	F	12-6	*	F	12-6	*	8	6	C	6
G	4	7	G	● ●●●	71	G	12-7	*	G	12-7	*	8	7	4	7
H	4	8	H	● ●●	72	H	12-8	*	H	12-8	*	8	8	4	8
I	4	9	I	●● ● ●	73	I	12-9	*	I	12-9	*	9	0	C	9
J	4	A	J	●● ● ●	74	J	11-1	*	J	11-1	*	4	1	C	A
K	4	B	K	● ● ●●	75	K	11-2	*	K	11-2	*	4	2	4	B
L	4	C	L	●● ●●	76	L	11-3	*	L	11-3	*	4	3	C	C
M	4	D	M	● ● ●	77	M	11-4	*	M	11-4	*	4	4	4	D
N	4	E	N	● ●●●	78	N	11-5	*	N	11-5	*	4	5	4	E
O	4	F	O	●● ●●●	79	O	11-6	*	O	11-6	*	4	6	C	F
P	5	0	P	● ● ●	80	P	11-7	*	P	11-7	*	4	7	5	0
Q	5	1	Q	●● ● ●	81	Q	11-8	*	Q	11-8	*	4	8	D	1
R	5	2	R	●● ● ●	82	R	11-9	*	R	11-9	*	5	0	D	2
S	5	3	S	● ● ●●	83	S	0-2	*	S	0-2	*	2	2	5	3
T	5	4	T	●● ● ●	84	T	0-3	*	T	0-3	*	2	3	D	4
U	5	5	U	● ● ● ●	85	U	0-4	*	U	0-4	*	2	4	5	5
V	5	6	V	● ● ●●	86	V	0-5	*	V	0-5	*	2	5	5	6
W	5	7	W	●● ● ●●●	87	W	0-6	*	W	0-6	*	2	6	D	7
X	5	8	X	●● ●●	88	X	0-7	*	X	0-7	*	2	7	D	8
Y	5	9	Y	● ●● ●	89	Y	0-8	*	Y	0-8	*	2	8	5	9
Z	5	A	Z	● ●● ●	90	Z	0-9	*	Z	0-9	*	3	0	5	A
[	5	B	[or ¾	●● ●● ●●	91	[	12-8-2	M		12-8-4	M	8	C	D	B
\	5	C	\ or ¢	● ●● ●	92	¬	11-8-7	#	\	11-8-7	M			5	C
]	5	D	] or cr	●● ●● ● ●	93	]	11-8-2	M		0-8-6	M	2	E	D	D
^	5	E	^ or °	●● ●● ●●	94	+	12-8-6	#						D	E
-	5	F	-	● ●● ●●●	95	-	0-8-5	#	-	0-8-2	M	2	A	5	F
~	7	E	~ or ◊	●●●● ●●	126	/	12-8-7	#		12-8-7	M	8	F	7	E
DEL	7	F		●●●●● ●●●	127	DELETE	12-9-7	M						F	F

Key: * Keys on 026, 029, A 142 and A 150 punch correct code.
M Multipunch on 026, 029, A 142 and A 150.
Keys on 029 and A 150 punch correct code; multipunch on 026 and A 142.
I Keys on 029 and A 150 punch invalid code; multipunch on 026, 029, A 142 and A 150.

TABLE OF INPUT CODE ASSIGNMENTS

A Table of Input Code Assignments provides the means by which any type of paper tape code (BCL, etc.) may be read and interpreted into the Series L/TC internal code (USASCII). The table not only permits any type of code (from any 5, 6, 7, or 8 channel tape), but also enables assigning any desired character or certain functions to be interpreted from a particular code. Tables are available for such common code sets as BCL, IBM 046, Friden and 5 Channel Teletype (Baudot); however, any other code set (up to 8 channels or bits) may be incorporated.

Input tape that contains USASCII code does not require a table for conversion, but may use a table if special functions are desired from certain codes.

The conversion table, where required, is stored in the Normal (or user) area of memory and occupies up to 16 words. Each code (character) in the tape is represented by a pattern of punches in one position (or frame) which constitutes a unique configuration of "bits." As codes are read from tape, each code references its own character position in the conversion table based on its "bit" configuration. In other words, the bit configuration of the code serves as an "address" to a specific position in the table. The way in which that code is interpreted is determined by the internal code value that the programmer has placed in that position of the table. The tables available represent "standard" interpretations of characters and functional codes. The internal code representing an input code may be changed in the table to suit a user's particular need and give any desired interpretation as outlined in the following paragraphs.

INPUT FUNCTIONS FOR 6, 7, or 8 CHANNEL TAPE BASED ON THE TABLE OF CODE ASSIGNMENTS

An input code is interpreted in any one of the following ways depending on the internal code placed in its position in the table (does not apply to 5 channel code):

1. Interprets the incoming code as one of the Series L/TC printable (graphic) characters when the internal code for that character is contained in that position of the table.
2. Ignores the incoming code when the Series L/TC internal code for Ignore is contained in that position of the table.
3. Interprets the incoming code as an invalid character when a forced parity error is contained in that position of the table. This turns on the Invalid Code Indicator Light and sets Reader Invalid Code flag.
4. Causes the incoming code to set any or all of the flags of one flag group (the Y or K flag groups). The flags can then be tested as part of the user program, to provide alternate results. Codes that set the Y or K flags also terminate the read instruction. Incoming codes interpreted in this manner serve as Field Identifier codes and do not provide a printable Series L/TC character.
5. Causes the incoming code to set any or all of the Accumulator (A) Flags during a Read Numeric instruction. This permits numeric data to be read as minus and/or identified uniquely (as per hundred, etc.). The flags can then be tested to cause alternate results as part of the user program. Codes that set the Accumulator Flags do not terminate the Read instruction; therefore, they can be located in any character position in the data field on the tape. They do not provide a printable character during read-in, but as in the case of the Sign flag, subsequent Print Numeric instructions can be affected.

The codes described in paragraphs 4 and 5 above may or may not correspond to those codes that are normally considered "control" or "functional" in a given code set, depending on the interpretation value given to them in the table by the programmer.

FIRMWARE SUBSETS FOR THE TABLE OF CODE ASSIGNMENTS

Specific GP 300 Firmware subsets are provided with paper tape input/output capability. However, the Table of Code Assignments is usually loaded into memory as part of the user program load procedure. This permits using various code sets at different times with the same user program, or permits use of a different code set with each separate user program without changing the firmware, with certain exceptions:

1. Input with any code set requiring conversion to the internal code (USASCII), with a table of code assignments, requires a firmware subset that provides "table look-up." Input with USASCII does not require "table look-up" firmware since no conversion is necessary. However, various code sets can be used as input to the same system, along with USASCII, so long as "table look-up" firmware is used and a table of code assignments is provided for each code set including USASCII.
2. Firmware for 5 channel code includes "table look-up" capability; however, it is different than firmware for 8, 7, or 6 channel code, or for USASCII (no table look-up).

USASCII PAPER TAPE CODE WITHOUT TABLE LOOK-UP FIRMWARE

When USASCII is the paper tape input code, a table of code assignments is not required, and a separate Firmware subset is provided.

The following chart shows the code that represents each of the USASCII characters on tape (even parity). Each character is represented by two hexadecimal digits: the left for the upper four bits, the right for the lower four bits. As the tape is read and after parity checking, the parity bit (b8) is set to zero before the character is stored in memory; therefore, if a tape code's upper four bits are A, B, C, or D, they would become 2, 3, 4, or 5 memory respectively. (See Appendix D.)

Sp	A, 0	0	3, 0	@	C, 0	P	5, 0
!	2, 1	1	B, 1	A	4, 1	Q	D, 1
"	2, 2	2	B, 2	B	4, 2	R	D, 2
#	A, 3	3	3, 3	C	C, 3	S	5, 3
$	2, 4	4	B, 4	D	4, 4	T	D, 4
%	A, 5	5	3, 5	E	C, 5	U	5, 5
&	A, 6	6	3, 6	F	C, 6	V	5, 6
'	2, 7	7	B, 7	G	4, 7	W	D, 7
(	2, 8	8	B, 8	H	4, 8	X	D, 8
)	A, 9	9	3, 9	I	C, 9	Y	5, 9
*	A, A	:	3, A	J	C, A	Z	5, A
+	2, B	;	B, B	K	4, B	3/4 ([)	D, B
,	A, C	½ (<)	3, C	L	C, C	¢ (\ )	5, C
-	2, D	=	B, D	M	4, D	CR (])	D, D
.	2, E	¼ (>)	B, E	N	4, E	° (^)	D, E
/	A, F	?	3, F	O	C, F	_	5, F
				DEL	F, F	<> (~)	7, E

FIELD IDENTIFIER (TERMINATION) CODES: The following chart shows the paper tape USASCII control codes which cause tape read instructions to be terminated, and some of which set a specified flag pattern. Each code is represented by two hexadecimal digits. Codes in column 1 of the table set the "K" flags. These codes do not enter into memory.

USASCII COLUMN 0 FIELD IDENTIFIER CODES**					
		FLAG PATTERN SET BY CODE*			
		Y FLAG NUMBER			
CODE	PAPER TAPE VALUE	3	2	1	4
NUL	0,0	0	0	0	0
SOH	8,1	0	0	0	1
STX	8,2	0	0	1	0
ETX	0,3	0	0	1	1
EOT	8,4	0	1	0	0
ENQ	0,5	0	1	0	1
ACK	0,6	0	1	1	0
BEL	8,7	0	1	1	1
BS	8,8	1	0	0	0
HT	0,9	1	0	0	1
IF	0,A	1	0	1	0
VT	8,B	1	0	1	1
FF	0,C	1	1	0	0
CR	8,D	1	1	0	1
SO	8,E	1	1	1	0
SI	0,F	1	1	1	1

USASCII COLUMN 1 FIELD IDENTIFIER CODES					
		FLAG PATTERN SET BY CODE*			
		OCK FLAG NUMBER			
CODE	PAPER TAPE VALUE a, b	3	2	1	4
DLE	9,0	0	0	0	0
DC1	1,1	0	0	0	1
DC2	1,2	0	0	1	0
DC3	9,3	0	0	1	1
DC4	1,4	0	1	0	0
NAK	9,5	0	1	0	1
SYN	9,6	0	1	1	0
ETB	1,7	0	1	1	1
CAN	1,8	1	0	0	0
EM	9,9	1	0	0	1
SUB	9,A	1	0	1	0
ESC	1,B	1	0	1	1
FS	9,C	1	1	0	0
GS	1,D	1	1	0	1
RS	1,E	1	1	1	0
US	9,F	1	1	1	1

*0 = flag is reset; 1 = flag is set

**Firmware sets are available which prevent the setting of the Y flags when these codes are read.

The NUL code is the same as a sprocket feed code in that no channels are punched in a frame, and thus, it functions differently than the other field identifier codes. During a read tape instruction, it is ignored (treated like a delete code – DEL) until the first significant character of data is read. If encountered after the first significant character, it will then be treated as a field identifier code and will terminate the read instruction. It should not be used for a field identifier code if a variable field of data would ever contain no significant data but only a field identifier code. This would cause the NUL code to be ignored, since a significant character was not read, and it would not serve its intended function to terminate the instruction. This would result in the paper tape getting out of step with the program.

The END OF ALPHA (code 0,0) is the same as the NUL code.

The DEL (Delete) code is completely ignored by all paper tape read instructions, and does not count as a character read. It consists of a punch in all 8 channels in a frame of tape.

TAPE CODES				ACCUMULATOR FLAGS*			
				M	C	S	-
A,0		C,0	5,0	0	0	0	0
2,1		4,1	D,1	0	0	0	1
2,2		4,2	D,2	0	0	1	0
A,3		C,3	5,3	0	0	1	1
2,4		4,4	D,4	0	1	0	0
A,5		C,5	5,5	0	1	0	1
A,6		C,6	5,6	0	1	1	0
2,7		4,7	D,7	0	1	1	1
2,8		4,8	D,8	1	0	0	0
A,9		C,9	5,9	1	0	0	1
A,A	3,A	C,A	5,A	1	0	1	0
2,B	B,B	4,B	D,B	1	0	1	1
A,C	3,C	C,C	5,C	1	1	0	0
2,D	B,D	4,D	D,D	1	1	0	1
2,E	B,E	4,E	D,E 7,E	1	1	1	0
A,F	3,F	C,F	5,F	1	1	1	1

TABLE OF OUTPUT CODE ASSIGNMENTS

When a code set other than USASCII is desired in the output tape, or when certain variations may be desired in the USASCII set, a Table of Output Code Assignments may be used. This permits output into any 5, 6, 7, or 8 channel code without modification to the Perforator. Output in USASCII code does not require a table.

The table is loaded into a Normal memory area and occupies up to 16 words. The loading may accompany regular loading of user programs. This table is a separate table from the Table of Input Code Assignments described above. Each Series L/TC internal character selects a particular character position in the output table. The 8-bit code that is put in each character position of the table is the code that will be punched into the output tape.

Normally, the Punch Code (XC) instruction will be used to punch field identifier (functional) codes. However, since any of the Series L/TC internal characters, through the table, can cause any 8-bit code to be punched, field identifier codes may be punched in this manner also.

The programmer may construct an output table to achieve any desired output code. However, tables are available that contain "standard" values for the following code sets:

BCL/IBM	8 channel
Friden	8 channel
USASCII	8 channel
Teletype	5 channel (Baudot)

The bit configuration of most Friden tape codes is the same as BCL. However, many of the functional code names given to the various codes are different, and for that reason a table is provided for ease in interpretation.

FIRMWARE SUBSETS FOR THE TABLE OF CODE ASSIGNMENTS

The firmware which includes "table look-up" for conversion of the internal code to the output code is different than firmware which does not use "table look-up" (output in USASCII). Thus, a USASCII table is available for use in systems that require "table look-up" firmware due to varying output code requirements.

NOTE: Output in 5-channel tape code requires firmware that is different from either 8-channel "table look-up" firmware or for output in USASCII without "table look-up."

GP 300 TIMINGS

This section contains the timings for GP 300 instructions as recorded by tests on Firmware Set 2-1002-001-02. The timings are averages depending upon two factors:

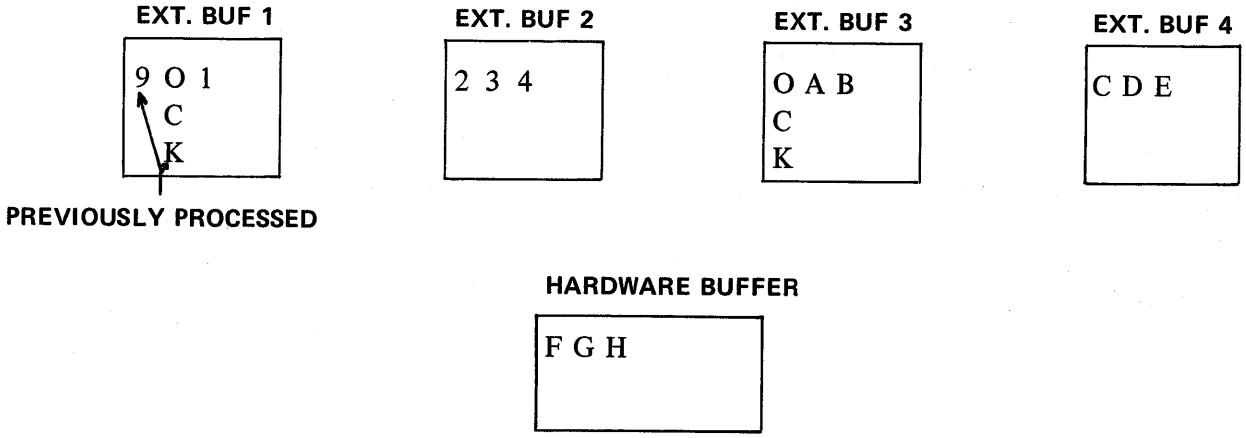
1. The Firmware Set being used.
2. The context in which the particular macro instruction appears, in particular fetch time and other disk position considerations.

TIMINGS

The following instruction timings were measured on firmware set 2-1002-001-02, with the instruction placed in syllable zero. When an instruction is placed in syllable three (3) or the execution of the instruction causes a word boundary to be crossed, an additional 10 to 20 milliseconds will be required for a new instruction word access.

When the keyboard extension buffers are full and the hardware buffer (A3) contains at least three (3) characters an additional 10 ms must be added to every macro instruction.

This condition could occur with 13 entries in the buffers. The following is a typical example of this condition.



The 9 and one OCK were processed on the last keyboard instruction. Extension buffer 1 now contains 1 entry to be processed. Extension buffers 2, 3, and 4 each contain 3 entries.

When the hardware buffer receives 3 or more entries an attempt will be made to unload the hardware buffer. Since the extension buffers are full the unloading cannot take place. Thus, an additional 10 ms cycle will occur with each new instruction fetched, until at least one buffer is emptied and the hardware buffer is unloaded.

MACRO INSTRUCTION	EXECUTION TIME IN MS
ADA	50
ADIR	20
ADK	30
ADM	70
BRU	20
CHG	20

MACRO INSTRUCTION		EXECUTION TIME IN MS	
CLA		20	
CLM		40	
CPA		60	
DIR		20	
DIV		*	SEE NOTE 2
EX		20	
EXE		20	
EXL		20	
EXZ		20	
IIR		20	
INK		20	
LIR		20	
LKBR		20	
LLCR		30	
LLLR		30	
LOD		30	
LPKR		30	
LPNR		30	
LRCR		30	
LRLR		30	
MOD		30	
MUL		*	SEE NOTE 3
MULR		*	SEE NOTE 3
NOP		10	
PKA		20	
PKB		20	
POS		10	SEE NOTE 4
REM		30	
RR		20	
RST		20	
SET		20	
SK		20	
SKE		20	
SKL		20	
SKZ		20	
SLRO		*	SEE NOTE 1
SLROS		*	SEE NOTE 1
SRJ		40	
SRR	Stack address	0 = 50	
	Stack address	1 = 60	
	Stack address	2 = 70	
	Stack address	3 = 80	
SUA		50	
SUK		30	
SUM		70	
TAIR		50	
TRA		30	
TRM		30	

The following instructions are variable, since mechanical synchronization is required. These may vary from machine to machine. The minimum and maximum execution times shown were measured on machine serial #Q1001P.

MACRO INSTRUCTION	FORMS COMMANDS	EXECUTION TIME IN MS
ALARM		20-50
AL	1 LINE	60-80
	10 LINES	480-520
AR	1 LINE	60-80
	10 LINES	480-520
ALR	1 LINE	60-80
ALTO	10 LINES	550-590
ARTO	10 LINES	550-590
CC		210-280
OC		210-280

	PRINT COMMANDS *SEE NOTE 4	
PA	Per character	50 ms
PC		30-70
PC+	a) If no print occurs	10
PC–	b) If print occurs	30-70
PN	a) First digit or punctuation printed is 90-120 ms; all succeeding places are 50 ms each	
	b) 10 ms per digit or punctuation suppressed.	

An additional 250 ms will be required for the first printing instruction encountered after exiting the READY MODE unless the carriage is closed prior to executing one of the following instructions.

PA	PN
PC	PNS+
PC+	PNS–
PC–	TK
PCP	TKM

KEYBOARD COMMANDS

NK

40	ms per digit
80	ms per OCK
110	ms per PSK

*SEE NOTE 5
*SEE NOTE 6

TK

BASE	=	20-50 ms (due to mechanical Timing)
CHARACTER	=	50 ms
OCK	=	100 ms – from hardware buffer
OCK	=	110 ms – from extension buffer
PSK	=	130 ms – from hardware buffer
PSK	=	140 ms – from extension buffer

*SEE NOTE 5
*SEE NOTE 6

TKM

BASE	=	20-50 ms
CHARACTER	=	50 ms
OCK	=	100 ms – from hardware buffer
OCK	=	110 ms – from extension buffer
PSK	=	130 ms – from hardware buffer
PSK	=	140 ms – from extension buffer

*SEE NOTE 5
*SEE NOTE 6

30 ms required to load each word to memory. This will occur every 8 characters or upon receiving a termination code.

EAM

CHARACTER	=	40 ms
OCK	=	100 ms – from hardware buffer
OCK	=	110 ms – from extension buffer
PSK	=	130 ms – from hardware buffer
PSK	=	140 ms – from extension buffer

30 ms required to load each word to memory. This will occur every 8 characters or upon receiving a termination code.

*SEE NOTE 5
*SEE NOTE 6

NOTE 1

Shift Timing

SLRO

SLROS

Base		=	30 ms
0-3	shifts	=	10 ms
4-6	shifts	=	20 ms
7-9	shifts	=	30 ms
10-12	shifts	=	40 ms
13-15	shifts	=	50 ms

Compute number of shifts left
and number of shifts right.

NOTE 2

Divide

1. a. Set down dividend (15 digits) followed by 15 zeros.
   b. Subtract divisor from dividend and repeat until dividend is smaller than divisor.
   c. Using the number of successful subtractions:

For no. = 0 to 3	set down 10 ms
For no. = 4 to 8	set down 20 ms
For no. =9,10,11	set down 30 ms

   d. Shift divisor one place to the right and repeat steps a, b, c, d for 15 times.
   e. Add base timing of 70 ms to total obtained above.
   f. Multiply scale factor by 10 ms and add to total obtained in e.

NOTE 3

Multiply

1. Set down scale factor.
2. When scale factor is not equal to zero:
   a. Examine the accumulator contents for timing purposes.
   b. For each accumulator digit starting least significant digit.

For digit = 0 to 6	set down 10 ms
For digit = 6 to 9	set down 20 ms

   c. Subtract 1 from scale factor and repeat steps 2 a, b, c until scale factor becomes zero.

3. When scale factor = zero
   a. For digit = 0 to 3 — set down 10 ms
      For digit = 4 to 8 — set down 20 ms
      For digit = 9 — set down 30 ms
   b. Repeat step 3a for each digit of accumulator until most significant digit of accumulator contents is reached.
   c. Add base timing of 70 ms to total obtained above.

NOTE 4

Positioning

Carrier positioning time must be added to the following instructions.

TK	PA
TKM	PC+
	PC–
	PN

Positioning Timings:

0-6	positions	–	300 ms
6-150	positions	–	300 ms + 5 ms for each position beyond 6

NOTE 5

When the extension buffers each contain entries, the buffer full flag will be set. When the first extension buffer word is completely processed, an additional 10 ms is required to reset the buffer full flag.

NOTE 6

10 ms must be added to the last entry when processed from each of the extension buffers or the hardware buffer.

MODIFICATIONS NECESSARY TO THIS MANUAL FOR PROGRAMING THE 40 TRACK STYLE SERIES L

Previously presented information in this manual applies only to 32 Track Styles of the Series L except for Assembler VI which utilizes the 40 track styles of the Series L. This appendix details all the additional information needed to utilize this assembler manual when programing the Extended Memory Styles.

An object program which was assembled for a 32 track system will operate on a 40 track system using 40 track firmware, except for the REM instruction. An object program which was assembled for a 40 track system will operate only on a 40 track system.

GP 300 OPERATION CODE MODIFICATIONS

Forty track systems allow the use of any GP 300 instruction explained in this manual except for the Data Communications Message Handling instructions, see pages 2-62 to 2-87. All user memory may contain program data or any other desired data. However, certain instructions do not permit referencing memory locations above word 511. These instructions are listed in Table K-1 below:

INSTRUCTIONS
ADA
CLM
CPA
DIV
MUL
MULR
SUA
XA

Table K-1

Instructions which only can reference words 0 to 511 of user memory

It is essential that the instructions contained in Table K-1 be borne in mind when moving or accumulating data in memory. Generally, the machine language codes are the same for either 32 track or 40 track systems. Examine Appendix B, Table 1 for the 32 track system machine language codes. Table K-2 contains the machine language codes for 40 track systems.

		MACHINE LANGUAGE CODE				
INSTRUCTION	FOR WORDS	OP CODE		PARAMETER		REFERENCE
		UPPER	LOWER	UPPER	LOWER	
ADM	0-255	8	0	O-F	O-F	
	256-511	8	1	O-F	O-F	
	512-767	8	2	O-F	O-F	
BRU	0-255	7	0	O-F	O-F	1
	256-511	7	1	O-F	O-F	1
	512-767	7	2	O-F	O-F	1

		MACHINE LANGUAGE CODE				
INSTRUCTION	FOR WORDS	OP CODE		PARAMETER		REFERENCE
		UPPER	LOWER	UPPER	LOWER	
LCFR	0-255	D	C	O-F	O-F	
	256-511	D	D	O-F	O-F	
	512-767	D	E	O-F	O-F	
LKBR	0-255	F	0	O-F	O-F	
	256-511	F	1	O-F	O-F	
	512-767	F	2	O-F	O-F	
LPKR	0-255	F	C	O-F	O-F	
	256-511	F	D	O-F	O-F	
	512-767	F	E	O-F	O-F	
LPNR	0-255	F	8	O-F	O-F	
	256-511	F	9	O-F	O-F	
	512-767	F	A	O-F	O-F	
PA	0-255	1orC	8	O-F	O-F	1
	256-511	1orC	9	O-F	O-F	1
	512-767		A	O-F	O-F	1
REM	0-767	3	B	4	1	
SRJ	0-255	2	0	O-F	O-F	1
	256-511	2	1	O-F	O-F	1
	512-767	2	2	O-F	O-F	1
SUM	0-255	9	0	O-F	O-F	
	256-511	9	1	O-F	O-F	
	512-767	9	2	O-F	O-F	
TRA	0-255	3	8	O-F	O-F	
	256-511	3	9	O-F	O-F	
	512-767	3	A	O-F	O-F	
TRM	0-255	3	0	O-F	O-F	
	256-511	3	1	O-F	O-F	
	512-767	3	2	O-F	O-F	
XPA	0-255	1	C	O-F	O-F	
	256-511	1	D	O-F	O-F	
	512-767	1	E	O-F	O-F	
	OR					
	0-255	C	A	O-F	O-F	
	256-511	C	B	O-F	O-F	

Table K-2

REFERENCE:

1. OP code lower digit requires modification according to word syllable.

   Modify thusly:

Syllable 0	add 0	to previous value
Syllable 1	add 4	to previous value
Syllable 2	add 8	to previous value
Syllable 3	add 12	to previous value

Example:

What is the machine language code for the instruction "Branch to word 625 syllable 2"?

Examine table K-2.

The OP code upper and lower for a branch to word numbers between 511 and 676 are 72. Reference 1 indicates add 8 to OP code lower (2+8=A) resulting in 7A.

The hexadecimal value for the difference between word 625 and word 511 (625–511=114) is 72.

The machine language code becomes 7A72.

ASSEMBLING PROGRAMS FOR 40 TRACK SYSTEMS

The information below is the only material which is needed in addition to Section 5 when attempting to assemble a symbolic program whose object program will function in an environment which allows extended memory macro programs.

Assembler I — pages 5-1 to 5-16

L/TC (32 track) Environment — Paper Tape I/O version

When EXTMEM prints on the journal, depress OCK 1 to indicate this is an assembly for a 40 track Style L. See page 5-1.

Assembler II — pages 5-17 to 5-21

L/TC (32 track) Environment — 80 Column Card I/O version

The control card $ EXTMEM indicates that the object program will utilize firmware which allows a macro program of 767 words.
See page 5-17.

Assembler III — pages 5-22 to 5-34

B 3500 Environment

The option EXTMEM will indicate that the size of user memory is 767 words.
See page 5-22.

Assembler IV pages 5-35 to 5-38

B 5500 Environment

The option EXTMEM will indicate that the size of user memory is 767 words
See page 5-35.

Assembler V pages 5-39 to 5-49

B 300 Environment

The control card $ EXTMEM signals the assembler that the object program will operate in a system which allows 767 words of user memory.

Assembler VI pages 5-50 to 5-65

L (40 Track) Environment

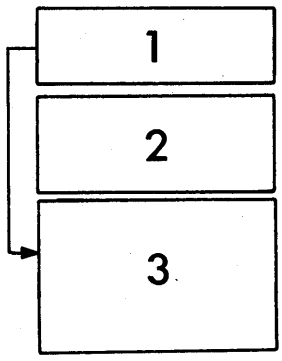
This is the Paper Tape I/O, Series L Keyboard Assembler for a 40 Track Style L. Reference the pages indicated above.

PROGRAMING CONSIDERATIONS

Due to the fact that some instructions cannot reference user memory locations above word 511, it is necessary that all constant data and working data be assembled in memory locations below word 511. The remaining memory is then used for program instructions.

The following example illustrates a generally used programing principle to obtain the results described above.

Example:



The three rectangles above illustrate a technique to have the working and storage area of the program assembled below memory word 511.

Rectangle 1 represents word 0. The first three syllables (0, 1, 2) contain programing. Syllable 4 contains a branch around rectangle 2 to rectangle 3.

Rectangle 2 contains the working-storage area.

Rectangle 3 contains further programing as required for data manipulation.

The following sample program illustrates the technique described above.

LABEL	OP CODE	A	B	C
	LLLR	35		
	LRLR	15		
	LPKR	PKEYS		
	BRU	BEGIN		
TOTALS	REG	200		
ZERO	NUM	0		
STORE	REG	150		
BEGIN	NK	5	1	

With the expanded memory size it may become necessary to clear a memory area larger than 255 words. This cannot be accomplished, easily, in a single loop since Index Registers have a maximum value of 255.

The following technique is recommended:

OP CODE	A	+/– INCREMENT	B	C
LIR	1		0	
MOD	1			
CLM	TOTAL			
MOD	1			
CLM	TOTAL	+ 200		
IIR	1		199	
SK	T		I	1
BRU		– 6		

The above programing clears 400 words of memory beginning with the word number referenced by TOTAL.

Example:

This example illustrates a method to reference an array of memory larger than 255 words. Controlling such an array of memory must be accomplished by examining the indexing value and changing the base address for values over 255.

Problem: Accumulate sales by 500 product codes (in words 1 to 500).

The programing segment below utilizes the fact that Index Registers have a capacity of 255. When a value transferred to an Index Register exceeds 255, only the difference between that value and 256 remains in the Index Register. See page 2-37.

LABEL	OP CODE	A	B	C	REMARKS
	SRJ	CLEAR			
	LPNR	PMASKS			
	BRU	BEGIN			
	ORG	1			
TOTAL 1	REG	500			
BEGIN	AL	1			
	POS	10			
	NK	3	0		Enter Product Code
	SKL	2	5	2	Valid Code 0-499
	ALARM				
	BRU		–3		
	TRM	CODE			Store Valid Code
	PN	2	0		Print Code
	POS	16			
	NKR	8	0		Enter Amount
	PNS–	7	1		Print Amount
	TRM	AMOUNT			Store Amount
	TRA	CODE			
	TAIR	1			
	SUA	LIMIT			Compare Code to 256
	EX	A	–	3	
	TRA	AMOUNT			Under 256
	MOD	1			
	ADM	TOTAL 1			
	SK	A	–	3	
	TRA	AMOUNT			
	MOD	1			
	ADM	TOTAL 1			Use Base of 1
	SK	A	–	3	Equal to or above 256
	MOD	1			
	ADM	TOTAL 2			Use Base of 257
	BRU	BEGIN			
TOTAL 2	DEF	257			

MODIFICATIONS NECESSARY TO THIS MANUAL FOR PROGRAMING THE TC 700

Appendix L defines the additional information required to program the TC 700 utilizing this manual. This information includes two classes of flags to be interrogated with the basic SKIP and EXECUTE macro instructions and a condensed numeric printing ability implemented by the basic PRINT NUMERIC instructions.

FLAG INSTRUCTIONS

The lock flags and passbook signal flags may be interrogated using the SKIP and EXECUTE instructions (see page 2-48). They cannot be referenced with the SET, RESET, LOAD or CHANGE macro instructions.

Lock Flags (V flag group)

Three flags are provided which test the status of the Teller 1 lock, Teller 2 lock and Supervisor lock. These are:

Flag V1 for the Teller 1 flag

Flag V2 for the Teller 2 flag

Flag V3 for the Supervisor Override Flag

Flag V4 is not used

When the Teller 1 key is inserted in its lock and turned, the Teller 1 flag will be set. When the key is removed from its lock, the Teller 1 flag will be reset. The same applies to the Teller 2 key and the Supervisor key.

INSTRUCTION	OP CODE	A	B	C
Skip if any flags	SK	V	123	1-4
Skip if every flag	SKE	V	123	1-4
Execute if any flags	EX	V	123	1-4
Execute if every flag	EXE	V	123	1-4

Passbook Signal Flags (W flag group)

Three flags test the sensors in the passbook alignment area. These are:

Flag W4 for 1st Print Line

Flag W1 for Passbook Fold

Flag W2 for Last Line

Flag W3 not used

When the Passbook is inserted to the fixed rear limit, the 1st Print Line Flag will be set. It will be reset at all other times. When the Passbook is so situated in the alignment area that the current print line will fall within the passbook fold area, the Passbook Fold Flag will be set. It will be reset when this condition does not exist.

When the Passbook is so aligned that the current print line is below the last printing line of the Passbook, the last Print Line Flag will be set. It will be reset when the passbook is aligned to any of the actual printing lines of the book.

A separate Passbook Present Flag does not exist. This condition can be determined by testing for the NOT SET condition of the Last Line Flag. This result occurs because if a passbook is present in the alignment mechanism and is aligned to any of the possible posting lines of the passbook, the Last Line Flag will be reset. The flag will be set if the passbook is aligned to the line below the last print line or if there is no passbook in the mechanism at all.

INSTRUCTION	OP CODE	A	B	C
Skip if any flags	SK	W	124	1-4
Skip if every flag	SKE	W	124	1-4
Execute if any flag	EX	W	124	1-4
Execute if every flag	EXE	W	124	1-4

Machine language code for V and W flag groups.

Reference the appropriate SKIP or EXECUTE instruction in Appendix B.

Use the weights:

Parameter upper position:

V flags	use E
W flags	use F

Parameter lower position:

FLAG	WEIGHT
W1 or V1	2
W2 or V2	4
W3 or V3	8
W4 or V4	1

PRINT IN PLACE CAPABILITY

The ability to print in place is actuated by the insertion of a dash (–) in digit position 15 of the mask word. This will print the comma (,) and period (.) without letting the printer actually escape the 1/10 inch normally permitted.

ALPHABETICAL INDEX

ALPHABETICAL INDEX (continued)


Wherever There's
Business There's
Burroughs