CONTROL DATA
CORPORATION

CONTROL DATA®
915 PAGE READER

8092 TAS
TELEPROGRAMMER ASSEMBLY SYSTEM

SOFTWARE REFERENCE MANUAL

RECORD OF REVISIONS

REVISION	NOTES
A	Manual Released 3/1/67
B	Revised 6/27/67
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G	Revised Operating Procedures Section, corrected minor
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H	
1/31/72	New cover; no changes to text; removed Tables 5-2, 6-2 as
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SECTION 1

INTRODUCTION

The TeleProgrammer Assembly System (TAS) allows programs written in TeleProgrammer Assembly Language (TAL) to be assembled on the 8092B TeleProgrammer. User TAS symbolic programs can be introduced from the CONTROL DATA® 915 Page Reader or from the Mod 33 or Mod 35 Teletypewriter. The system data flow is illustrated in Figure 1-1.

TAS occupies three files on a magnetic tape. File 1 contains the first pass routines which have the capability of substituting a teletype (TTY) input for the normal 915 Page Reader symbolic input. The second file contains a restart procedure (a means of by-passing the first pass on reassemblies) and the Binary Loader program which is read from punched paper tape at the TTY prior to initiating the second pass. The third file contains the second pass routines.

An assembly is a three-pass process since both a binary output and a listing are produced on the TTY. This requires making separate passes for punching the binary paper tape and for printing the listing. Only one program can be assembled at a time -- no stacking is possible.

TAL includes, in addition to the standard 8092 instruction repertoire, a set of 8092 pseudo-codes, a set of 915 Page Reader function and status codes and a set of 915 Page Reader macro functions. The inclusion of the 915 function and status codes and macros simplifies the coding of programs written to control the 915 Page Reader.

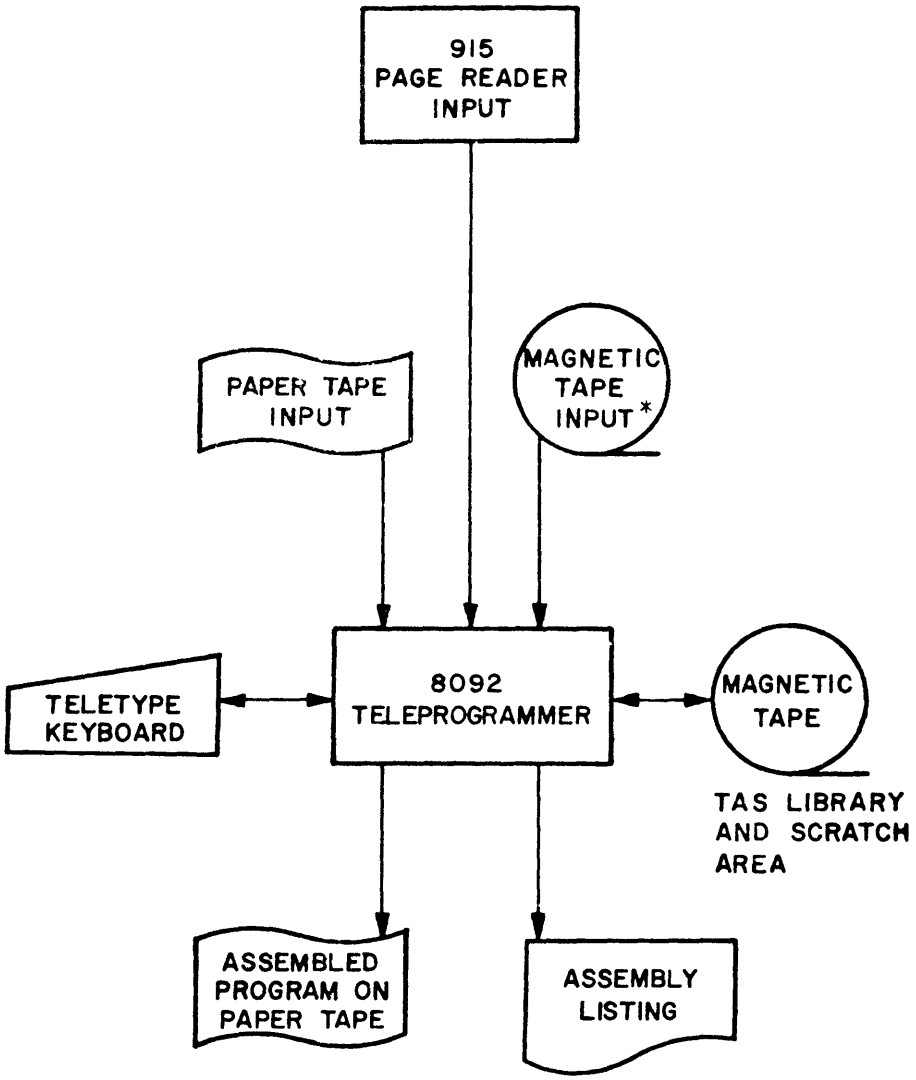
The TAS program operates with the following equipment:

915 Page Reader with
  8022 Page Reader Controller
8092 TeleProgrammer
8096 or 8196 Input/Output Teletypewriter
601 Magnetic Tape Transport with
  8193 or 8194 Magnetic Tape Controller or
608 or 609 Magnetic Tape Transport with
  8194 Magnetic Tape Controller

The following optional equipment may also be used:

8156 Line Printer
8291 Paper Tape Punch
8299 Paper Tape Reader

When two magnetic tape transports are available, the program can be assembled and loaded faster from magnetic tape input than from 915 Page Reader or TTY input. The 8156 Line Printer, 8291 Paper Tape Punch, and 8299 Paper Tape Reader can be used to increase the speed of input and output operations by using a suitably modified TAS program.



NOTE
* REQUIRES TWO MAGNETIC TAPE TRANSPORTS

Figure 1-1. System Data Flow

SECTION 2

TAS INSTRUCTION REPERTOIRE

8092 TELEPROGRAMMER CODES

For a detailed description of the 8092 instructions refer to the 8092 Teleprogrammer, Programming Reference Manual.

The following symbols describe the operation of instructions:

- t = tag register designation (t = 1, 2, 3 or blank)
- f = function code
- m = 8-bit word execution address (may include address 2 as additive unless n specified)
- n = same as m but second address, no additive allowed.
- y = 8-bit operand (may include address 2 as additive unless z specified)
- z = same as y but second operand, no additive allowed

Load, store, jump, arithmetic logical, input/output, and miscellaneous instructions are defined in Tables 2-1 through 2-7.

TABLE 2-1. LOAD INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
LDN y	Load A, no address	20	2	2
LDM, t m	Load A, memory	21	2	3
LDI, t m	Load A, indirect	22	2	4
LCM, t m	Load A, compl, memory	25	2	3
LCI, t m	Load A, compl, indirect	26	2	4
TTA, t	Tag register to A	03	1	1
CLA	Clear A to zero	03	1	1
BER	Buffer entrance register to A	06	1	1

* Each cycle is 4.33 microseconds.

TABLE 2-2. STORE INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
STM, t m	Store A, memory	41	2	3
STI, t m	Store A, indirect	42	2	4
ATT, t	A to tag register	02	1	1
ABR, t m	A to buffer entrance register	04	2	1 or 2**
ABX, t m	A to buffer exit register	05	2	1 or 2**

TABLE 2-3. JUMP INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
ZJP, t m	Jump if A=0 (positive)	60	2	1 or 2**
NZP, t m	Jump if A≠0	61	2	1 or 2**
PJP, t m	Jump if A positive	62	2	1 or 2**
NJP, t m	Jump if A negative	63	2	1 or 2**
UJP, t m	Unconditional jump	64	2	2

TABLE 2-4. ARITHMETIC INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
ADN y	Add, no address	30	2	2
ADM, t m	Add, memory	31	2	3
ADI, t m	Add, indirect	32	2	4
SBN y	Subtract, no address	34	2	2

* Each cycle is 4.33 microseconds.
** Two cycles are required if a jump is made.

TABLE 2-4. ARITHMETIC INSTRUCTIONS (CONT'D)

Instruction	Function	Octal Code	Number Words	Number of Cycles*
SBM, t m	Subtract, memory	35	2	3
SBI, t m	Subtract, indirect	36	2	4
RAM, t m	Replace add, memory	51	2	4
RAC, t m	Replace add One, memory	55	2	4

TABLE 2-5. LOGICAL INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles *
LPN y	Logical product, no address	10	2	2
LPM, t m	Logical product, memory	11	2	3
LPI, t m	Logical product, indirect	12	2	4
LSN y	Logical sum, no address	14	2	2
LSM, t m	Logical sum, memory	15	2	3
LSI, t m	Logical sum, indirect	16	2	4

TABLE 2-6. INPUT/OUTPUT INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
INN, t m n	Input, normal channel	72	3	3+2(n+1)†
OUT, t m n	Output, normal channel	73	3	3+2(n+1)†
IBI, t m	Input, buffer channel	70	2	1 or 2**
IBO, t m	Output, buffer channel	71	2	1 or 2**

* Each cycle is 4.33 microseconds.
**Two cycles are required if a jump is made and instruction is not performed.
† Time depends on external equipment transfer rate.

TABLE 2-6. INPUT/OUTPUT INSTRUCTIONS (CONT'D)

Instruction	Function	Octal Code	Number Words	Number of Cycles*
INA	Input to A	76	1	2
OTN y	Output, no address	74	2	2
EXF y z	External select	75	3	3

TABLE 2-7. MISCELLANEOUS INSTRUCTIONS

Instruction	Function	Octal Code	Number Words	Number of Cycles*
CIL	Clear interrupt lockout	13	1	1
CIR	Clear interrupt return	113	1	1
CBC	Clear buffer control	07	1	1
ERR	Program halt	00	1	1
HLT	Program halt	77	1	1
DON	Do nothing	02	1	1
SHA	Shift left 1 bit, circular	01	1	1

8092 TELEPROGRAMMER PSEUDO-CODES

The 8092 pseudo-codes are defined in Table 2-8.

TABLE 2-8. 8092 PSEUDO-CODE INSTRUCTIONS

Instruction	Function
SHA y	Generate y shifts (1-7). If the y-field for this instruction is not blank, it will be interpreted and the number of shifts specified, up to 7, will be generated. If interpretation of the y-field results in a value greater than 7, seven shifts will be generated.

* Each cycle is 4.33 microseconds.

TABLE 2-8. 8092 PSEUDO-CODE INSTRUCTIONS (CONT'D)

Instruction		Function
SPL	y	Space y lines on listing. The y-field is interpreted and the result specifies the number of lines to be skipped on the listing. If the end of a page is reached, any remaining skips are discarded. In this connection, a y-field value of 60D or more is equivalent to a "skip page" function.
REM		Remarks only follow. A line containing this pseudo-code is printed without modification.
EQU	y	Equate tag to tag or tag to constant. The y-term is interpreted and the result equated to the tag found in the location field.
ORG	y	Set address counter to y. The y-term is interpreted and the result substituted in the location counter.
BSS	y	Increment address counter by y. The y-term is interpreted and the result added to the location counter.
BCD	y	Preset storage to following BCD character codes. The y-term is interpreted and the result indicates the number of BCD characters in the comments field. The 6-bit octal equivalents of these characters are generated and stored in consecutive locations. If the y-field value exceeds the comments field (maximum of 39 characters), 39 characters will be interpreted and an error indicated on the listing.
TTY	y	Preset storage to following teletype codes. Same function as BCD except 8-bit teletype codes are generated.
(blank)	y	One-word constants can be generated by leaving the operation field blank and inserting mnemonics, decimal or octal constants in the address fields. Constants are indicated by a blank operation field code (If the entire line is blank, it will be ignored.) The y-term is interpreted and the result becomes the contents of the current location.

TABLE 2-8. 8092 PSEUDO-CODE INSTRUCTIONS (CONT'D)

Instruction	Function
TAS	Initiate assembly. Location field contains program identification. The first line accepted by the assembler must be a TAS pseudo-code. The first four characters in the location field serve to identify the binary output of the assembly, and these characters may not be blanks.
END	Terminate assembly pass. The last line processed for an assembly must be an END pseudo-operation.

915 PAGE READER FUNCTION AND STATUS CODES

The function codes are used to control 915 Page Reader operations and the status codes enable the 8092 to monitor status conditions within the 915 Page Readers.

The function codes are divided into Class 1, 2, and 3 functions. The Class 1 functions enable the 915 Page Reader to perform the commanded operation only when the 915 Page Reader status is Ready and Not Busy. The Class 2 functions enable the 915 Page Reader to perform the commanded operation when a Ready status exists. The Class 3 status requests and functions are responded to or performed regardless of the 915 Page Reader status.

Class 1 functions are subdivided into Class 1A, 1B, and 1C functions which are described in Table 2-9. Class 1A functions set the parameters of the next operation and cause no status change after the performance of the function. The Class 1B functions initiate mechanical actions which change the 915 Page Reader status to Busy. While Busy status exists, no other Class 1 functions can be performed. The Class 1C functions are program-initiated alarms which cause the 915 Page Reader operation to stop. The status becomes Not Ready and only Class 3 status request functions can be performed until the Not Ready status is cleared.

Class 2 functions cause the three counters on the Operator's panel to be cleared or advanced and enable or clear the SELECT FUNCTION #1, #2, or #3 pushbutton indicators. Class 2 functions are described in Table 2-10.

Class 3 status requests cause the 915 Page Reader to respond with its operational status, and are described in Table 2-11.

Class 3 functions start or stop the 915 Page Reader operation and are described in Table 2-11.

For detailed descriptions of Class 1, 2, and 3 functions, refer to CONTROL DATA® 8022-A/B Page Reader Controller Reference Manual (Pub. No.

60167100) or CONTROL DATA® 3195-A Page Reader Controller Reference Manual (Pub No. 60166900).

TABLE 2-9. CLASS 1 FUNCTION CODES

Instruction	Function	Octal Code	Number Words	Number of Cycles*
CLASS 1A				
SPA	Select page advance	756701	3	3
SMF	Select mirror forward	756702	3	3
SMR	Select mirror reverse	756703	3	3
ANM	Select alphanumeric	756710	3	3
ALF	Select alpha read	756711	3	3
NUM	Select numeric read	756712	3	3
MKS	Select mark sense read	756713	3	3
R3P	Read 3/inch (double space)	756714	3	3
R6P	Read 6/inch (single space)	756715	3	3
CLASS 1B				
SCS	Start coordinate search	756704	3	3
ZM	Position mirror to coordinate zero	756705	3	3
LL	Line locator	756707	3	3
PS	Sort to primary	756750	3	3
SS	Sort to secondary	756751	3	3
MK	Mark document	756757	3	3

* Each cycle is 4.33 microseconds.

TABLE 2-9. CLASS 1 FUNCTION CODES (CONT'D)

Instruction	Function	Octal Code	Number Words	Number of Cycles*
CLASS 1C				
APE	Alarm program error	756752	3	3
AHR	Alarm header reject	756753	3	3

TABLE 2-10. CLASS 2 FUNCTION CODES

Instruction	Function	Octal Code	Number Words	Number of Cycles*
CEN	Clear entry, partial total, subtotal, end of file	756777	3	3
CT1	Advance counter 1	756730	3	3
CT2	Advance counter 2	756732	3	3
CT3	Advance counter 3	756734	3	3
CL1	Clear counter 1	756731	3	3
CL2	Clear counter 2	756733	3	3
CL3	Clear counter 3	756735	3	3
PAR	Select partial	756761	3	3
SUB	Select subtotal	756762	3	3
TOT	Select total	756764	3	3
CPR	Clear partial	756771	3	3
CST	Clear subtotal	756772	3	3
CTT	Clear total	756774	3	3

* Each cycle is 4.33 microseconds.

TABLE 2-11. CLASS 3 STATUS AND FUNCTION CODES

Instruction	Function	Octal Code	Number Words	Number of Cycles*
RS1	Request status 1	756740	3	3
RS2	Request status 2	756742	3	3
RMS	Request mirror coordinate	756741	3	3
LR	Line read	756744	3	3
STP	Stop read and mirror	756747	3	3

915 PAGE READER MACRO INSTRUCTIONS

Macro instructions used to control the 915 Page Reader, the function performed by each instruction, and the machine code generated are listed in Table 2-12.

* Each cycle is 4.33 microseconds.

TABLE 2-12. 915 PAGE READER MACRO INSTRUCTIONS

Instruction	Function	No. Words	Code Generated
EMV, t	Wait for LMV, RMV or SKL operation to complete. The t must indicate tag register referencing EMV instruction location. EMV is a status loop waiting for a compare status. EMV can be used following LMV, RMV or SKL. A tag register must be designated unless first word lies in bank 0. EMV is not recommended for use because it causes program to wait for a compare operation. The possiblity exists that compare will be missed causing a program halt.	8	075 RS1 "REQUEST STATUS 1" 067 040 076 INA 010 LPN 20 020 t 60 ZJP,t * -6 "WAIT FOR COMPARE" nnn †
LIN,t y	Input a line to buffer area referenced by tag register t, starting bank address y, and ending address plus one. Right mirror motion must have been initiated. LIN inputs 915 Page Reader characters to buffer area specified by designated tag register, y field (address 1) and additive field (address 2). The y field contains first address and additive field contains number of words to be input.	6	075 LR "REQUEST LINE READ" 067 044 t 72 INN,t "INPUT CHARACTERS" yyy y+z

† nnn refers to the address of the jump generated by the assembler.

TABLE 2-12. 915 PAGE READER MACRO INSTRUCTIONS (CONT'D)

Instruction	Function	No. Words	Code Generated
LMV y	Start mirror moving left to coordinate y. The y field contains destination coordinate of mirror move.	8	075 SMR "SELECT MIRROR REVERSE" 067 003 074 OTN y "OUTPUT DESTIN. COORD." yyy 075 SCS "START COORD. SEARCH" 067 004
LOC, t	Wait up to 300 milliseconds to find line locator symbol. If found, A REGISTER is positive on exit. The t must indicate tag register referencing the LOC instruction location. LOC searches area of current mirror position for line locator symbol. A status word is then sent to A REGISTER. If line locator symbol is not found, some mechanical motion instruction (e.g., SKP) should be programmed before programming another LOC instruction. Tag register must be designated unless first word of macro instruction lies in bank 0.	11	075 LL "SEARCH FOR LINE LOC." 067 007 075 RS1 "REQUEST STATUS 1" 067 040 076 INA 001 SHA t 63 NJP,t * -5 "WAIT FOR NOT BUSY" nnn 001 SHA

TABLE 2-12. 915 PAGE READER MACRO INSTRUCTIONS (CONT'D)

Instruction	Function	No. Words	Code Generated
NBY,t y	Test 915 Page Reader status for Not Busy. If Busy status exists, jump to location specified by t and y. If * appears in y field, this indicates wait function.	7	075 RS1 "REQUEST STATUS 1" 067 040 076 INA 001 SHA t 63 NJP,t y "BUSY JUMP" yyy
POS†,t y	Wait until mirror position y is reached. The t must indicate tag register referencing POS instruction location. The y field contains a mirror coordinate. POS waits until mirror reaches this coordinate. POS should be preceded by a move (LMV, RMV, or SKL) instruction. A tag register must be designated unless first word lies in bank 0.	8	075 RMS "REQUEST MIRROR STATUS" 067 041 076 INA 034 SBN y yyy t 61 NZP,t * -6 "WAIT FOR COORD. nnn .
RDY,t y	Test 915 Page Reader status for Ready. If Not Ready status exists, jump to location specified by t and y. If * appears in y field, this indicates wait function.	6	075 RS1 "REQUEST STATUS 1" 067 040 076 INA t 62 PJP,t y "N-READY JUMP" yyy

† Occasionally 915 Page Reader skips a coordinate causing NZP instruction to be skipped and leaving program in a loop. After program is assembled, a PJP or NJP instruction, depending on desired mirror direction can be substituted for NZP instruction so that program can leave loop.

TABLE 2-12. 915 PAGE READER MACRO INSTRUCTIONS (CONT'D)

Instruction	Function	No. Words	Code Generated
RJC,t y	Test 915 Page Reader status for Line Reject. If Line Reject status exists (read error), jump to location specified by t and y.	8	075 RS1 "REQUEST STATUS 1" 067 040 076 INA 010 LPN 10 010 t 61 NZP,t y "REJECT JUMP" yyy
RMV y	Start mirror moving right to coordinate y. The y field contains destination coordinate of mirror move.	8	075 SMF "SELECT MIRROR FORWARD" 067 002 074 OTN y "OUTPUT DESTIN.COORD." yyy 075 SCS "START COORD. SEARCH" 067 004
RNB,t y	Test 915 Page Reader status for Ready and Not Busy. If both conditions are NOT met, jump to location specified by t and y. If * appears in y field, this indicates wait function.	9	075 RS1 "REQUEST STATUS 1" 067 040 076 INA t 62 PJP,t y "N-READY JUMP" yyy 001 SHA t 63 NJP,t y "BUSY JUMP" yyy

TABLE 2-12. 915 PAGE READER MACRO INSTRUCTIONS (CONT'D)

Instruction	Function	No. Words	Code Generated
SKL y	Start mirror moving left to coordinate y. Skip number of lines indicated in additive field. The y field (address 1) contains destination coordinate and additive field (address 2) contains number of lines to be skipped.	13	075 SMR "SELECT MIRROR REVERSE" 067 003 074 OTN y "OUTPUT DESTIN. COORD." yyy 075 SPA "SELECT PAGE ADVANCE" 067 001 074 CTN "OUTPUT NUMBER LINES" yyy 075 SCS "START COORD. SEARCH" 067 004
SKP y	Start paper skipping y lines. The y field contains number of lines to be skipped.	8	075 SPA "SELECT PAGE ADVANCE" 067 001 074 CTN y "OUTPUT NUMBER LINES" yyy 075 SCS "START COORD. SEARCH" 067 004

SECTION 3

SYMBOLIC INPUTS AND CODING FORMATS

TAS allows symbolic inputs from the 915 Page Reader or teletype. Preliminary coding for any input medium can be done on a OSAS/OSAS-A TAS 915 Coding Form (Pub. No. AA2212). Data from this form can then be typed and read on the 915 Page Reader for preparation of punched paper tape object program, or input directly from the TTY.

The programmer normally uses either the coding form shown in Figure 3-1 or 3-6 for his handwritten coding. His program is then typed on the TAS 915 Coding Form shown in Figure 3-2 for 915 Page Reader input, punched on paper tape as shown in Figure 3-3 to be input later on the TTY Paper Tape Reader, or typed into the TTY as shown in Figure 3-4. Character and symbol codes for the 915 Page Reader and the Mod 33 and Mod 35 TTY are listed in Table 3-2.

PROGRAM LISTING

A TAS listing produced on the TTY is shown in Figure 3-5. Although 12-bit octal values are represented as storage contents, only the lower 8-bits are punched on the binary paper tape (i.e., 1064 = 064 on tape). Note that after 60 lines are printed, six lines are skipped on the continuous TTY form.

Error lines are indented by four character spaces and contain an error message code character as shown in 1 through 5 of Figure 3-5. Error characters are stored in the character position related to the error field (i.e., location field errors are in the first character position, address 2 errors in the fourth character position). The error message code characters are defined in Table 4-1.

The sample program shown in Figure 3-4 and the sample listing shown in Figure 3-5 contain five programming errors. These errors are defined on the sample listing as follows:

1. The L in the first character position indicates an illegal symbolic tag in the location field. In this case, an alpha "O" was typed in BE01 instead of a zero.

2. The U in the third character position indicates that the address 1 tag was undefined. In this case, BE02 should have a zero rather than an alpha "O".

3. The U in the third character position indicates that the address 1 tag was undefined. In this case, the program was unable to locate BE01 because of error 1.

4. The A in the third character position indicates an illegal format in the address 1 field which in this case is the BEG+3 instruction.

5. The T in the second character position indicates an illegal tag register designator in the operation field. In this case, +4 is an illegal instruction.

BINARY PAPER TAPE

The binary paper tape produced by TAS contains parity bits and checksums for ensuring data validity. Data words are broken into two 4-bit frames. An odd parity bit is included as a five-level punch with the second frame of the data word. Checksums follow all special functions (TAS, ORG/BSS, END) or every ten data words, whichever occurs first. Checksums are the arithmetic sums of the previous checksum and any intervening data words. The following five-place codes identify the special functions punched on a TAS binary tape:

TAS	30 = 11000
ORG/BSS	22 = 10010
END	24 = 10100
CHECKSUM	21 = 10001

CODING FIELDS

LOCATION FIELD

The location field may be blank or may contain a symbolic tag consisting of one to four characters, the first of which must be non-numeric. If a four character tag is used, the last two characters must be numeric. Illegally formatted tags will be flagged as errors on the listing. A symbol which appears in this field more than once in a program will be flagged as an error. Any reference made to such a duplicate or illegal tag will be treated as undefined. The maximum number of tags for a program is 382.

OPERATION FIELD

If the operation field is blank, the address fields will be interpreted as a one word constant. If non-blank, the first three characters of the operation field must be an 8092 instruction or pseudo-operation, a 915 function or status code or a 915 macro instruction. Otherwise, the field will be flagged as an error on the listing. Numeric operation-codes may not be used.

The fourth character of the operation field must be a blank or a comma. If the fourth character is blank, no other character may be put in this field. If the fourth character is a comma, the fifth character of the field (tag register designation) must be a 1, 2, or 3. For 8092 instructions which may reference a tag register, a comma followed by a blank is flagged as an error.

ADDRESS 1 FIELD

The address 1 field may be blank or may contain a signed or unsigned tag or numeric. A single asterisk (*) as the left-most character of the field will be assigned the value of the address of the instruction. A tag in this field which does not appear in a location field somewhere in the program will be flagged on the listing as undefined.

Decimal or octal numerics may be used. Decimal numbers must be terminated with a "D". Octal numbers are terminated by a blank. The largest number allowed is 7777 (octal) or 4095 (decimal).

A sign followed by a blank will be flagged as an error. If the field is found to be in error, zero will be substituted for the field value.

ADDRESS 2 FIELD

Address 1 field rules also apply to address 2 fields. For one-word 8092 instructions and for 915 function and status operations, both address fields are ignored. For two-word 8092 instructions and for the 8092 pseudo-operations (excepting TAS, REM, END), address 2 field is treated as an additive to address 1 field. For three-word 8092 instructions, address 2 field contains the second address.

COMMENTS FIELD

Except for BCD and TTY pseudo-operations, the comments field is ignored and will appear on the listing as it appears on the input document, except that for 915 Page Reader input, leading blanks will be suppressed. Comment field characters may extend through the sequence field.

SEQUENCE FIELD

If the sequence field is non-blank, it will occupy the last six characters on the listing. Any characters from the comment field which occupy these positions will be overlayed by the contents of the sequence field.

915 PAGE READER INPUT FORMAT

Fields on the TAS 915 coding form as shown in Figure 3-2 for the 915 Page Reader are to be filled in with characters typed in ANSI (American National Standards Institute) font. Data lines are to be doubled-spaced. Fields are separated by vertical black lines (field separators). Blanks following these field separators are suppressed so that relative position within a field is unimportant.

If the first four fields of the form are blank, the line will be ignored. If the character "D" (delete) is typed to the left of the first field separator (as shown

in Figure 3-2), the line will be ignored. Lines on which read errors occur are marked and processed as read.

To terminate reading of a page, the symbol "E" (end) is typed to the left of the first field separator after the last line of instructions on each TAS 915 Coding Form, as shown in Figure 3-2. When the 915 Page Reader reads the E symbol, reading on that coding form is terminated and the next coding form is advanced to the read station.

MAGNETIC TAPE INPUT FORMAT

Information is input to the 8092 from a source magnetic tape which was generated using the 8092 Source on Tape (SOT) program. The fields on the source magnetic tape are in punched card image format (80 characters to a record). The contents of each field on this punched card image are similar to the TAS coding form format shown in Figure 3-1. The contents of each field or character position are listed in Table 3-1.

TABLE 3-1. PUNCHED CARD IMAGE FORMAT

Character Position	Content
1	Blank
2 to 5	Location field
6	Blank
7 to 9	Operation field
10	Comma, if required
11	Tag, if required
12	Blank
13 to 17	Address 1 field
18	Blank
19 to 23	Address 2 (additive) field
24	Blank
25 to 74	Comments field
75 to 80	Sequence field

TELETYPEWRITER INPUT FORMAT

Information is input to the 8092 from the TTY by typing in the information at the keyboard or by reading a punched paper tape. Keyboard input is sufficient for relatively short program (100 instructions or less). A drawback is that if errors occur in the assembled program, the entire corrected program must be retyped. Since errors frequently occur in transcribing from the coding sheet, this input method would be inefficient for a large program.

A symbolic punched paper tape can be prepared and edited off line. This tape can then be input from the teletype paper reader. Errors found in the program can then be edited off line and a new paper tape prepared.

DIRECT KEYBOARD INPUT

The following procedure should be followed to input a program into the 8092. The TTY prints a "greater than" symbol when it is ready to accept an input line. The operator then types a line of the program separating each field with a "slash" symbol and terminates the line by pressing "return" key. A "less than" symbol is printed to indicate that the line has been accepted, the carriage returns and the line advances in preparation for the next input. If an error is detected while typing a line, the "rub out" key should be depressed. The line will be ignored and a new input line requested.

PREPARING OFF LINE PAPER TAPE

To prepare an off line symbolic punched paper tape, follow the procedures listed in the Direct Keyboard Input paragraph with the following modifications:

a. No control characters except "carriage return", "line feed", or "rub out" should be punched. "Line feed" characters and blank frames are ignored if typed.

b. At least five "fill" characters should be punched after each line to allow time for processing the line and writing a tape record. The "here is" key will produce sufficient blank frames for this purpose unless a message has been wired to this key. If the "here is" key cannot be used, the "line feed" key may be depressed five times as a substitute.

TELETYPEWRITER ERROR MESSAGES

If an input error is indicated, then an illegal input character has been found. Input errors include control characters except "carriage return", "line feed", or "rub out". The line is ignored and a new input requested. If a field error is indicated, then too many characters are in the current field. The line is ignored and a new input requested by using a "greater than" symbol.

TABLE 3-2. CODES FOR 915 PAGE READER AND MOD 33 AND MOD 35 TELETYPE

915 Char.	TTY Char.	915	Mod 33	Mod 35	915 Char.	TTY Char.	915	Mod 33	Mod 35
A	A	61	301	101	W	W	26	327	327
B	B	62	302	102	X	X	27	330	330
C	C	63	303	303	Y	Y	30	331	131
D	D	64	304	304	Z	Z	31	332	132
E	E	65	305	305	{	(	32	333	50
F	F	66	306	306	}	)	74	335	251
G	G	67	307	107	↑	_	55	336	336
H	H	70	310	110	—	-	17	337	137
I	I	71	311	311	SPACE	SPACE	20	240	240
J	J	41	312	312	#	#	37	243	243
K	K	42	313	313	$	$	53	244	044
L	L	43	314	314	%	%	34	245	245
M	M	44	315	115	&	&	52	246	246
N	N	45	316	116	'	'	33	247	247
O	O	46	317	317	*	*	54	252	252
P	P	47	320	120	+	+	60	253	053
Q	Q	50	321	321	'	'	16	254	254
R	R	51	322	322	-	-	40	255	055
S	S	22	323	123	.	.	73	256	056
T	T	23	324	324	/	/	21	257	257
U	U	24	325	125	|		75		
V	V	25	326	126	↓		72		

TABLE 3-2. CODES FOR 915 PAGE READER AND MOD 33 AND MOD 35 TELETYPE (CONT'D)

915 Char.	TTY Char.	915	Mod 33	Mod 35
:	:	15	272	072
;	;	77	273	273
=	=	13	275	275
?	?	76	277	077
",▽	"	36	242	042
↑,↓	!	56	241	
0	0	12	260	060
1	1	01	261	261
2	2	02	262	262
3	3	03	263	063
4	4	04	264	264
5	5	05	265	065
6	6	06	266	066
7	7	07	267	267
8	8	10	270	270
9	9	11	271	071
	<		274	
	>		276	
‡,■	@	57	300	300
	LINE FEED		212	012
	CARRIAGE RETURN		215	215
	BELL		207	207
Reject		35		

CONTROL DATA CORPORATION — BABBAGE ENGINEERING DIVISION

TAS - CODING FORM

CLIENT/PROJECT: SAMPLE PROGRAM | PROGRAMMER/ANALYST: | DATE: MARCH 1, 1967 | PAGE 1 OF 1

LOC	OP	T	ADDR 1	ADDR 2	COMMENTS	SEQ
TST	TAS					
	REM				SAMPLE CØDING	
	SPL		2			
	ØRG		1000			
BEG	LDN		BTG			
	ATT	,1				
	RNB	,1	ERR			
BEØ1	ZN				SEARCH FØR LINE LØCATØR	
	LØC	,1				
	PJP	,1	BEØ2			
	SKP		1			
	UJP	,1	BEØ1			
BEØ2	HLT				LØØK NØ FURTHER	
BER	TTY		13D		915 NØT READY	
TMP	BSS		3			
ERR	EXF		TEL	TIØ	TYPE MESSAGE	
	ØUT	,1	BER	TMP		
	ERR					
	UJP	,1	BEG	+3		
TEL	EQU		36			
TIØ	EQU		5			
BTG	EQU		2			
CØN			BEG	-1	EXAMPLE ØF CØNSTANT	
	SPL		1			
	REM				EXAMPLE ØF CØDING ERRØRS	
ABCD	LDM	,4	DØN	+9	4 ERRØRS	
	END					

Figure 3-1. Sample Programmer's Coding Form

1 of 2

SAMPLE PROGRAM 3-1-67

SWH

```
        TST     TAS
                REM             SAMPLE CODING
                SPL     2
                ORG     1000
        BEG     LDN     BTG
                ATT,2
                ATT,1
                RNB,1   ERR
        BE01    ZM              SEARCH FOR LINE LOCATOR
                LOC,1
                PJP,1   BE02
                SKP     1
                UJP,1   BE01
        BE02    HLT             LOOK NO FURTHER
        BER     TTY     13D     915 NOT READY
        TMP     BSS     3
```

Figure 3-2. Sample 915 Coding Form (Sheet 1 of 2)

```
D
          ERR       EXF       TEL       TIO       TYPE MESSAGE
                    OUT,1     BER       TMP
                    ERR
                    UJP,1     BEG       +3
          TEL       EQU       36
          TIO       EQU       5
          BTG       EQU       2
          CON                 BEG       -1        EXAMPLE OF A CONSTANT
                    SPL       1
                    REM                           EXAMPLE OF CODING ERRORS
          ABCD      LDM,4     DON       +9        4 ERRORS
                    END
E
```

Figure 3-2. Sample 915 Coding Form (Sheet 2 of 2)

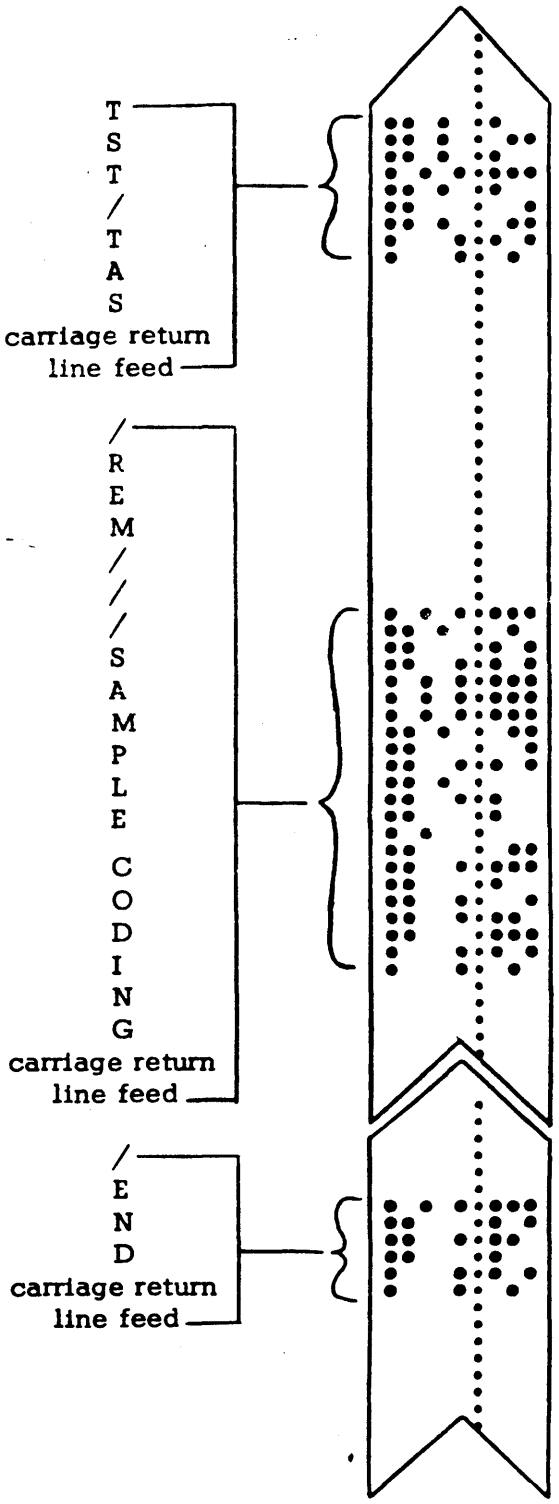


Figure 3-3. Sample Mod 33 Teletype Punched Paper Tape

```
    TAS-PASS 1
    TYPEWRITER INPUT
    >TST/TAS<
    >/REM///SAMPLE CODING<
    >/SPL/2<
    >/ORG/1000<
    ABEG/LDN/BTG<
    >/ATT,1<
    >/RNB,1/ERR<
(1) >BE01/ZM///SEARCH FOR LINE LOCATOR<
    >/LOC,1<
(2) >/PJP,1/BE02<
    >/SKP/1<
(3) >/UJP,1/BE01<
    >BE02/HLT///LOOK NO FURTHER<
    >BER/TTY/13D//915 NOT READY<
    >TMP/BSS/3<
    >ERR/EXF/TEL/TIO/TYPE MESSAGE<
    >/OUT,1/BER/TMP<
    >/ERR<
(4) >/UJP,1/BEG+3<
    >TEL/EQU/36<
    >TIO/EQU/5<
    >BTG/EQU/2<
    >CON//BEG/-1/EXAMPLE OF A CONSTANT<
    >/SDL/1<
(5) >/LDM,4/<
    >/END<
```

Figure 3-4. Sample Teletype Input

```
TAS-PASS 2
          TST  TAS
               REM                          SAMPLE CODING


     1000       ORG     1000
1000 0020 BEG   LDN     BTG
1001 0002
1002 0102       ATT,1
1003 0075       RNB,1   ERR
1004 0067
1005 0040
1006 0076
1007 0162
1010 1067
1011 0001
1012 0163
1013 1067
(1) L   1014 0075 BE01 ZM                   SEARCH FOR LINE LOCATOR
1015 0067
1016 0005
1017 0075       LOC,1
1020 0067
1021 0007
1022 0075
1023 0067
1024 0040
1025 0076
1026 0001
1027 0163
1030 1022
1031 0001
(2)  U 1032 0162       PJP,1 BE02
1033 0000
0134 0075       SKP   1
1035 0067
1036 0001
1037 0074
1040 0001
1041 0075
1042 0067
1043 0004
```

Figure 3-5. Sample TAS Listing (Sheet 1 of 2)

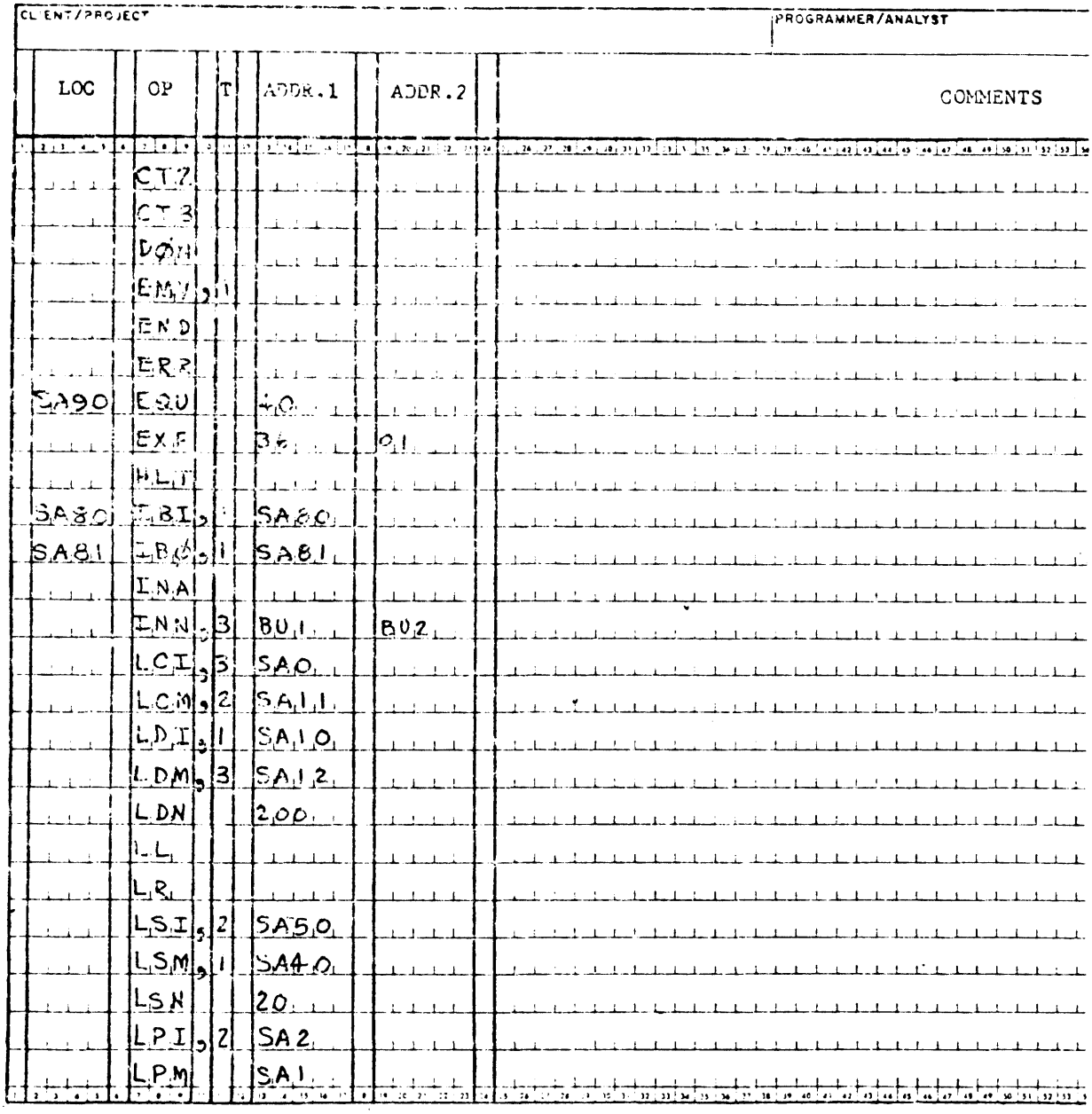
```
③   U 1044 0164        UJP,I BEGI
    1045 0000
    1046 0077 BEG2 HLT                      LOOK NO FURTHER
    1047 0271 BER  TTY   13D                915 NOT READY
    1050 0261
    1051 0265
    1052 0240
    1053 0316
    1054 0317
    1055 0324
    1056 0240
    1057 0322
    1060 0305
    1061 0301
    1062 0304
    1063 0331
    1064 0003 TMP  BSS   3
    1067 0075 ERR  EXF   TEL   TIO     TYPE MESSAGE
    1070 0036



    1071 0005
    1072 0173      OUT,I BER   TMP
    1073 1047
    1074 1064
    1075 0000      ERR
④   A 1076 0164      UJP,I BEG+3
    1077 0000
         0036 TEL   EQU  36
         0005 TIO   EQU  5
         0002 BTG   EQU  2
    1100 0777 CON       BEG   -1        EXAMPLE OF A CONSTANT
     0  1101 0000      SDL   1
    1102 0001
    1103 0000
⑤   T  1104 0021      LDM,4
    1105 0000
                  END
```

Figure 3-5. Sample TAS Listing (Sheet 2 of 2)

CLIENT/PROJECT | PROGRAMMER/ANALYST

LOC	OP	T	ADDR.1	ADDR.2	COMMENTS
	ABR,	2	SA2 0		
	ABX,	2	SA3 0		
	ADI,	2	SA3 7		
	ADM,	3	SA3 6		
	ADN		1 0		
	AHM				
	AHR				
	ALF				
	APE				
	ATT,	1			
	BCD		1 0 D		END ØF RUN
	BER				
	BSS		2 0 0 D		
	CBC				
	CEN				
	CIL				
	CIR				
	CLA				
	CL1				
	CL2				
	CL3				
	CPR				
	CST				
	CTT				
	CTI				

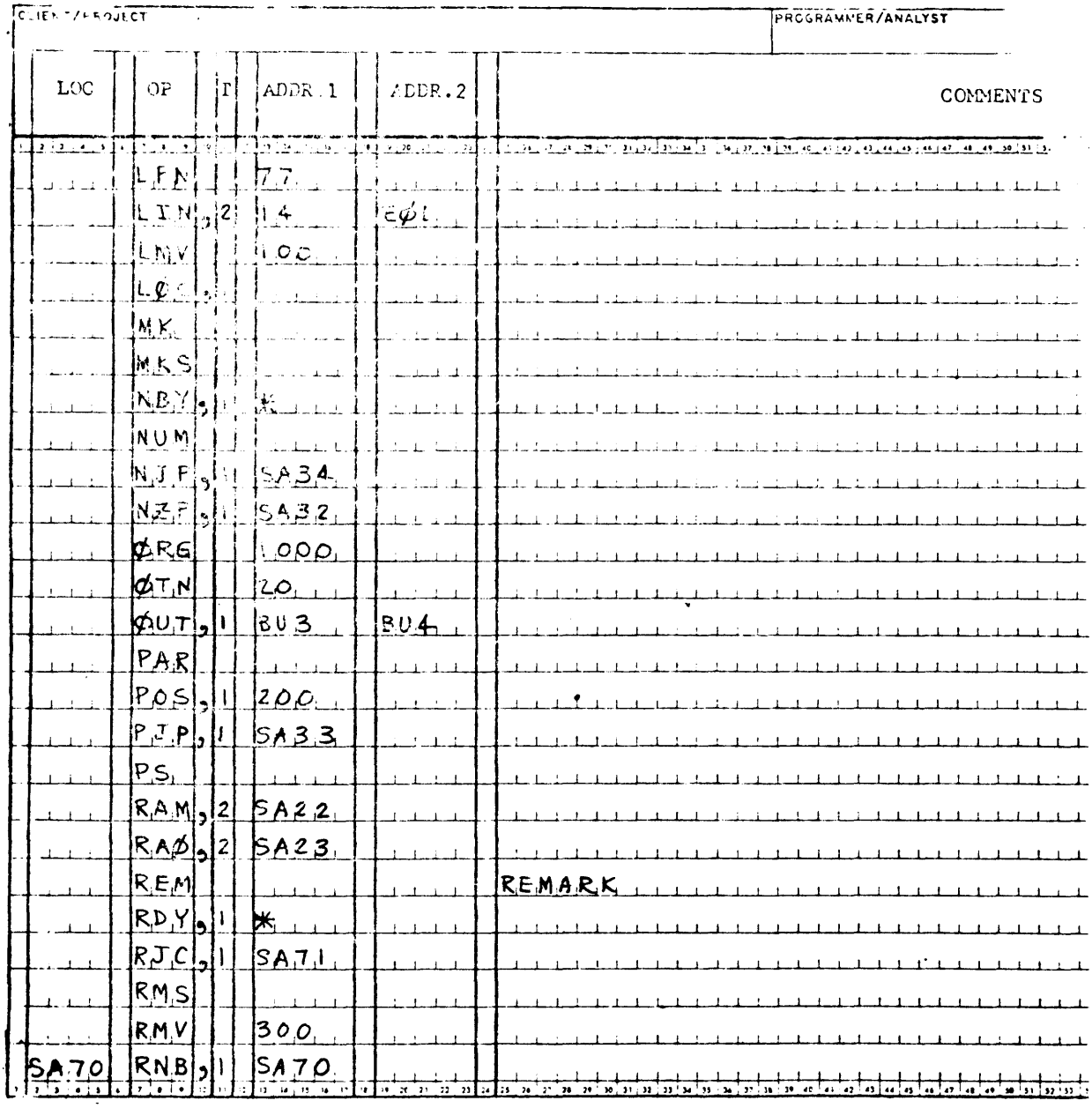
Figure 3-6. Sample Instructions (Sheet 1 of 4)



CLIENT/PROJECT | PROGRAMMER/ANALYST

LOC	OP	T	ADDR.1	ADDR.2	COMMENTS
	CT7				
	CT3				
	DØN				
	EMV	1			
	END				
	ERR				
SA90	EQU		+0		
	EXF		B6	Ø1	
	HLT				
SA80	IBI	1	SA80		
SA81	IBØ	1	SA81		
	INA				
	INN	3	BU1	BU2	
	LCI	3	SA0		
	LCM	2	SA11		
	LDI	1	SA10		
	LDM	3	SA12		
	LDN		200		
	LL				
	LR				
	LSI	2	SA50		
	LSM	1	SA40		
	LSN		20		
	LPI	2	SA2		
	LPM		SA1		

Figure 3-6. Sample Instructions (Sheet 2 of 4)



CLIENT/PROJECT | PROGRAMMER/ANALYST

LOC	OP	I	ADDR.1	ADDR.2	COMMENTS
	LFN		77		
	LIN	2	14	EØL	
	LNV		100		
	LØC				
	MK				
	MKS				
	NBY	1	*		
	NUM				
	NJP	1	SA34		
	NZP	1	SA32		
	ØRG		1000		
	ØTN		20		
	ØUT	1	BU3	BU4	
	PAR				
	POS	1	200		
	PJP	1	SA33		
	PS				
	RAM	2	SA22		
	RAØ	2	SA23		
	REM				REMARK
	RDY	1	*		
	RJC	1	SA71		
	RMS				
	RMV		300		
SA70	RNB	1	SA70		

Figure 3-6. Sample Instructions (Sheet 3 of 4)

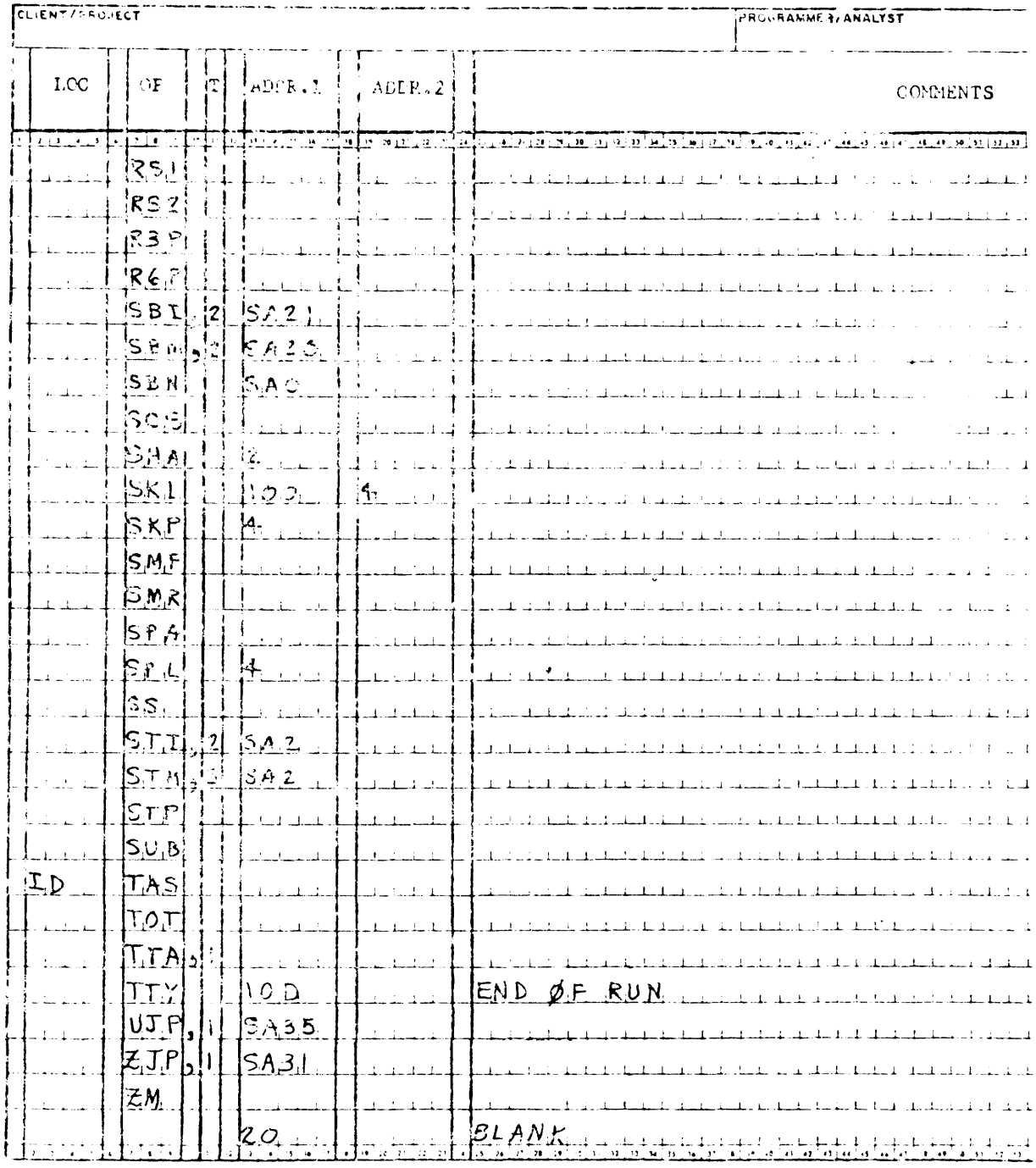


Figure 3-6. Sample Instructions (Sheet 4 of 4)

SECTION 4

TAS ERROR MESSAGES

Error message codes are written at the beginning of a line on a program listing. The line is then indented four positions to the right. Unique error positions for each of the four fields (i.e., location tag, operation code, address 1, address 2) are present on the listing. Position 1 corresponds to location tag errors; position 2 corresponds to operation code errors; and positions 3 and 4 correspond to address 1 and address 2 errors, respectively. Definitions of error symbols are listed in Table 4-1.

TABLE 4-1. ERROR SYMBOLS

Symbol	Error Field	Pass	Description of the Error
E	1,2,3,4	1	Read error, symbolic input
S	1	1	Symbol Table Full (tag not stored)
L	1	1	Illegal Symbolic Tag
D	1	1	Duplicate Tag
T	2	1	Illegal Tag Register designator (not 1-3)
O	2	1	Illegal Operation Code*
W	3&4	1	Address Field(s) undefined for Pass 1**
A	3	2	Address 1 lilegal format
B	4	2	Address 2 Illegal format
U	3	2	Address 1 Tag Undefined
V	4	2	Address 2 Tag Undefined
P	3&4	2	Magnetic tape parity error on read
C	3	2	Address 1 and Address 2 too large BCD, TTY value larger than 39 (maximum value), substitute 39. SHA - value larger than 7, substitute 7

* If an operation field code is in error, a three-word instruction is assumed and the address is incremented by this amount.

** Generated when the address field of a BCD, TTY or BSS pseudo code can not be evaluated correctly for Pass 1.

SECTION 5

OPERATING PROCEDURES

Procedures for operating TAS are described in Tables 5-1 through 5-4. Each table contains three columns. Numbers in the Step column indicate operating sequence. The Equipment column indicates the equipment at which each step is performed. The Procedure column describes actions to be performed and the results of these actions.

Table 5-1, Loading and Assembling the Program, contains procedures for normal assembly of a program from typewritten TAS 915 coding forms. During normal assembly, all data input from coding forms is written on the TAS library tape. If the TAS library tape containing this data is saved, the program can be reassembled without rereading the typed input data as defined in Table 5-3.

Table 5-2, Loading and Assembling the Program With Magnetic Tape Input, contains procedures for normal assembly of a program from source magnetic tape using two Magnetic Tape Transports. The source magnetic tape is generated using the 8092 Source on Tape (SOT) program.

Procedures for reassembly without repeating Pass are contained in Table 5-3, Loading and Restart Assembly. These procedures can be used when the TAS library tape containing the input data and symbol Table is saved. If the Binary Loader paper tape is damaged or a new listing is desired, the loading and restart assembly procedures are used.

Table 5-4, Using the Binary Loader, contains procedures used for the input of binary paper tape produced by TAS. The Binary Loader must be read into a memory bank not used by the assembled program to be loaded. The Binary Loader checks the validity of the binary data being loaded and halts if an error is detected. The A and Z REGISTER displays will indicate either successful loading or an error code.

Table 5-5, contains descriptions of abnormal program halts. The numbers in the Step column are for reference purposes only and do not indicate the sequence in which the halts occur. The Register Display column is divided into P, A, and Z REGISTER display columns. The contents of each register are listed for each abnormal program halt. The Procedure column defines the cause of the abnormal program halt and lists the procedures required to eliminate the problem and continue operation.

CAUTION

When setting spring loaded switches, ensure that switch does not spring back into opposite position. Damage to program could result.

TABLE 5-1. LOADING AND ASSEMBLING THE PROGRAM

Step	Equipment	Procedure
1	915/8092 System	Ensure that system is energized.
2	Magnetic Tape Transport	Mount TAS library tape with write ring. Set to Unit 3. Press LOAD and READY pushbutton indicators.
3	8092	Set MASTER CLEAR LOAD switch to MASTER CLEAR. NOTE If 8092 does not have autoload capacity, perform procedure from step 24.
4	8092	Set LOAD. Set RUN STEP switch to RUN. TAS library tape bootstrap program is read into memory locations 000 through 222. Program halts, P REGISTER displays 223. Set RUN STEP switch to center position.
5	8092	Set MASTER CLEAR. Set RUN. File 1 of TAS is read into memory and TAS library tape rewinds to end of bootstrap program. Program halts, P REGISTER displays 6324, and Z REGISTER displays 77. Set RUN STEP switch to center position. NOTE If abnormal program halt occurs, refer to Table 5-5.
6	Magnetic Tape Transport	Set to Unit 0.
7	8092	Press CLEAR T and TAG REGISTER SELECT 1 pushbuttons simultaneously. Press TAG REGISTER SELECT 1 pushbutton and simultaneously set 17 into TAG REGISTER.

TABLE 5-1. LOADING AND ASSEMBLING THE PROGRAM (CONT'D)

Step	Equipment	Procedure
		Set MASTER CLEAR. NOTE If 915 is used for program input, perform procedure from step 8. If Mod 33 TTY is used for program input, perform procedure from step 11. If Mod 35 TTY is used for program input, perform procedure from step 9.
8	915	Place TAS 915 coding forms into input hopper. Press LOAD DOCUMENT pushbutton indicator. Press HOPPER IN pushbutton indicator. DOCUMENT READY indicator lights. Press START pushbutton indicator. Perform procedure from step 12.
9	TTY	Set MODE switch to TTR.
10	8092	Key-in following patch (key-in procedures are defined in steps 24a through 24c): Storage Location (P REGISTER): 531, 534, 541 Content (A REGISTER): 132, 135, 164 Set 467 into P REGISTER.
11	8092	Set 002 into A REGISTER.
12	8092	Set RUN.
13	Magnetic Tape Transport	TAS library tape is positioned to file 2.

TABLE 5-1. LOADING AND ASSEMBLING THE PROGRAM (CONT'D)

Step	Equipment	Procedure
14	TTY	Prints out TAS PASS 1 and then prints out either 915 READER INPUT or TYPEWRITER INPUT. If TTY input is used, type in program to be assembled. Press ON pushbutton indicator on TTY Paper Tape Punch. NOTE If 8291 Paper Tape Punch is used, press PUNCH POWER pushbutton indicator.
15	Magnetic Tape Transport	TAS library tape is positioned beyond file 3 to scratch area. Input data is written on scratch area of tape. At conclusion of PASS 1, symbol table written on TAS library tape; tape rewinds, and is positioned at file 2. Intermediate pass (file 2) records are read into memory.
16	TTY or 8291 Paper Tape Punch	Binary Loader paper tape (used to read object tape into memory) is punched out. File 3 of PASS 2 routines are read into memory.
17	Magnetic Tape Transport	TAS library tape is positioned to data records following file 3 and data records are read into memory.
18	TTY or 8291 Paper Tape Punch	Binary (object) program is punched out. Press OFF pushbutton or PUNCH POWER pushbutton indicator.
19	Magnetic Tape Transport	TAS library tape rewinds and is positioned to scratch area. Records in scratch area are again read into memory.
20	TTY or 8156 Line Printer	Prints out listing.

TABLE 5-1. LOADING AND ASSEMBLING THE PROGRAM (CONT'D)

Step	Equipment	Procedure
21	8092	Program halts, A REGISTER displays 110, and Z REGISTER displays 177. Set RUN STEP switch to center position. NOTE If abnormal program halt occurs, refer to Table 5-5.
22	Magnetic Tape Transport	Dismount TAS library tape. This tape contains symbol table and input data written in scratch area. Save tape for use in loading and restart assembly procedures.
23	915/8092 System	See Table 5-3 for loading and restart procedures.
24	8092	Key-in following bootstrap program (key-in procedures are defined in steps 24a through 24c): Storage Location (P REGISTER) / Content (A REGISTER) / Interpretation 300 / 075 / Select Magnetic Tape Transport Unit 3 to read forward input from 000 to 222 223 = last word address + 1 301 / 013 302 / 024 303 / 072 304 / 000 305 / 223 306 / 000 a. Set ENTER SWEEP switch to ENTER. Set first storage location onto P REGISTER. b. Set Content corresponding to P REGISTER display into A REGISTER. Set STEP. Contents of A REGISTER are transferred to Z REGISTER and Storage Location in P REGISTER increases by 1.

TABLE 5-1. LOADING AND ASSEMBLING THE PROGRAM (CONT'D)

Step	Equipment	Procedure
		c. Repeat b until all Contents are keyed in. Set ENTER SWEEP switch to center position.
25	8092	Set MASTER CLEAR. Set 300 into P REGISTER. Set RUN. Program halts, P REGISTER displays 306, A REGISTER displays 223, and Z REGISTER displays 000.
26	8092	Set RUN STEP switch to center position. Perform procedure from step 5.

TABLE 5-2. LOADING AND ASSEMBLING THE PROGRAM WITH MAGNETIC TAPE INPUT

(To Be Supplied)

TABLE 5-3. LOADING AND RESTART ASSEMBLY

Step	Equipment	Procedure
1	915/8092 System	Ensure that system is energized.
2	Magnetic Tape Transport	Mount TAS library tape containing symbol table and input data (saved in step 22 of Table 5-1). Set to Unit 3. Press LOAD and READY pushbutton indicators.
3	8092	Set MASTER CLEAR LOAD switch to MASTER CLEAR. NOTE If 8092 does not have autoload capability, perform steps 24 and 25 of Table 5-1 and then perform procedure from step 4. Set LOAD. Set RUN STEP switch to RUN. Tape bootstrap program is read into memory location 000 through 222. Program halts, P REGISTER displays 223. Set RUN STEP switch to center position.
4	8092	Set MASTER CLEAR. Set 001 into A REGISTER. Set RUN. Program halts, Z REGISTER displays 077. NOTE If abnormal program halt occurs, refer to Table 5-5. Set RUN STEP switch to center position.
5	Magnetic Tape Transport	Set to Unit 0.
6	TTY Paper Tape Punch	Press ON pushbutton indicator.

TABLE 5-3. LOADING AND RESTART ASSEMBLY (CONT'D)

Step	Equipment	Procedure
7	8092	Press CLEAR T and TAG REGISTER SELECT 1 pushbutton simultaneously. Press TAG REGISTER SELECT 1 pushbutton simultaneously and set 001 into TAG REGISTER. Set MASTER CLEAR. Set RUN. Symbol table is read into memory, TAS library tape rewinds, two files are skipped, and part of Pass 2 is read.
8	TTY Paper Tape Punch	Binary Loader paper tape is punched. Press OFF pushbutton.
9	8092	Program halts when remainder of Pass 2 is read. A REGISTER displays 110 (maximum print field) and Z REGISTER displays 177. Set RUN STEP switch to center position.
10	8092	Select one of the following output options: For listing of complete output (all print fields) set RUN. For listing of error lines only, Press CLEAR A pushbutton, set 000 into A REGISTER, and then set RUN. For listing of octal fields only, press CLEAR A pushbutton, set 011 into A REGISTER, and then set RUN. For listing of octal fields and symbolic operation codes, press CLEAR A pushbutton, set 024 into A REGISTER, and then set RUN. For listing of all print fields except comments, press CLEAR A pushbutton, set 041 into A REGISTER, and then set RUN. For punched paper tape output, press CLEAR A pushbutton, set a negative number (e.g., 200) into A REGISTER, and then set RUN.

TABLE 5-3. LOADING AND RESTART ASSEMBLY (CONT'D)

Step	Equipment	Procedure
11	Magnetic Tape Transport	TAS library tape is rewound and positioned at data file.
12	TTY	Prints TAS PASS 2. NOTE If punched paper tape option is selected in step 10, press ON (TTY Paper Tape Punch). Prints listing and punches paper tape. Press OFF.
13	8092	Program halts, A REGISTER displays 110, and Z REGISTER displays 177. NOTE If abnormal program halt occurs, refer to Table 5-5.
14	915/8092 System	Repeat procedure from step 10 to obtain additional listings or punched paper tapes.

TABLE 5-4. USING THE BINARY LOADER

Step	Equipment	Procedure
1	915/8092 System	Ensure that system is energized.
2	8092	Set MASTER CLEAR LOAD switch to MASTER CLEAR. Key-in following paper tape bootstrap: (Key-in procedures are defined in steps 24a through 24c in Table 5-1.)

NOTE

Paper Tape bootstrap is loaded into bank zero. If another bank is to be used, set proper bank number into TAG REGISTER 2 or 3 and reference correct bank at jump instruction in Storage Location 004.

Storage Location (P REGISTER)	Content (A REGISTER)	Interpretation
000	075	Select TTY.
001	036	
002	005	
003	076	Input 1 word.
004	060	If 0, jump-back to get next word or else store word here.
005	000	
006	141	
007	000	
010	172	Input data:
011	001	first word address,
012	376	last word address + 1 (entire bank).
013	164	Jump to loader at beginning of

TABLE 5-4. USING THE BINARY LOADER (CONT'D)

Step	Equipment	Procedure
		Storage Location (P REGISTER) / Content (A REGISTER) / Interpretation 014 / 000 / binary object program.
3	8092	CAUTION Obtain bank number to be used for Binary Loader program from programmer. Binary Loader program must be read into a memory bank not used by assembled program to be loaded. Press TAG REGISTER SELECT 1 pushbutton. Set bank number which will store binary loader program into TAG REGISTER.
4	TTY	Mount Binary Loader and Object Program paper tape generated in steps 16 and 18 of Table 5-1.
5	8092	Set MASTER CLEAR and set RUN.
6	TTY or 8299 Paper Tape Reader	Set START STOP FREE switch to START or press READER POWER pushbutton indicator. Binary Loader and Object Program reads in.
7	8092	Program halts, Z REGISTER displays 077. NOTE If abnormal program halt occurs, refer to Table 5-5.
8	TTY	Prints TAS IDENT.
9	TTY or 8299 Paper Tape Reader	Set STOP or press READER POWER pushbutton indicator.
10	915/8092 System	To load additional object programs, repeat procedure from step 4, using appropriate paper tape.

Since the basic TAS assembler uses the end of the magnetic system tape for intermediate storage, the system tape must be used without file protection. For this reason and because it may be desired to save system tape for restart assemblies, a means of copying the system files to a new magnetic tape is required. (See Table 5-4A.)

Each system file contains a routine for loading that file into TeleProgrammer memory and for writing memory contents onto magnetic tape. Thus, by mounting and dismounting tapes the system files may be copied from one tape to another.

TABLE 5-4A. COPYING A MAGNETIC SYSTEM TAPE

Step	Equipment	Procedure
		Remove file protect ring from system tape to be copied. Select tape unit 3.
1	8092	Load first file. Mount system tape. Load Bootstrap record (see Table 5-1). Master Clear, Run. The first file will be read in, tape rewound and the bootstrap record read. Normal halt, Z - 077. Dismount tape.
2	8092	Write first file. Mount scratch tape. Master Clear, Run. The Bootstrap record will be written followed by memory contents and a file mark. Normal halt, Z = 077. Dismount tape.
3	8092	Load second file. Mount system tape. Load Bootstrap record (see Table 5-1). Master Clear. A = 001. Run. The first file will be skipped. The second file will be read in, tape rewound and the bootstrap record read. Normal halt, Z = 077. Dismount tape.

TABLE 5-4A. COPYING A MAGNETIC SYSTEM TAPE (CONT'D)

Step	Equipment	Procedure
4	8092	Write second file. Mount scratch tape. Master Clear. A = 001. Run. The first file will be skipped. The contents of memory will be written followed by a file mark. Normal halt, Z = 077. Dismount tape.
5	8092	Load third file. Follow the same process as for loading the second file (Step 3) except set A = 002 (skip 2 files).
6	8092	Write third file. Follow the same process as for writing the second file (Step 4) except set A = 002 (skip 2 files).
7	8092	Error Halts, Z = 000. Error Halts indicate a parity error either reading or writing. If put back in run from the halt location, an attempt will be made to reread or rewrite the bad record. No other recovery is possible.

TABLE 5-5. ABNORMAL PROGRAM HALTS

Step	Register Display P	A	Z	Procedure
1	0045		000	Tape error occurred after Pass 1 as bootstrap program loaded first records. Repeat procedure from step 3 of Table 5-1 or step 4 of Table 5-2.
2	6225		000	Tape error occurred after Pass 1 as remainder of file is read into memory. Repeat procedure from step 3 of Table 5-1 or step 4 of Table 5-2.
3	6321		000	Tape error occurred after Pass 1 as bootstrap program is reread. Ignore error unless copying TAS library tape. To ignore error: At 8092 set RUN. Follow procedures from step at which program halt occurred. If copying TAS library tape, repeat procedure from step 3 of Table 5-1 or step 4 of Table 5-2.
4		000	000	Tape error in reading intermediate pass or optional routine. TAS library tape malfunction. Replace TAS library tape and repeat procedure from step 2 of Table 5-1.
		000	000	TAS ident not found after Pass 2. Examine punched paper tape for damage and replace if required. Check alignment of paper tape in Paper Tape Reader. At 8092, set beginning address of Binary Loader into P REGISTER. Set RUN. Follow procedure from step 6 of Table 5-4. If malfunction recurs, prepare a new Binary Object paper tape by performing procedures in Table 5-3.

TABLE 5-5. ABNORMAL PROGRAM HALTS (CONT'D)

Step	Register Display P	A	Z	Procedure
5		001	000	915 is not ready for operation after intermediate pass.
	TTY prints READY READER			Ready 915 by performing procedure from step 8 of Table 5-1.
		001	000	Parity error occurs after Pass 2. Examine punched paper tape for damage and replace if required. Check alignment of paper tape in Paper Tape Reader. At 8092, set beginning address of Binary Loader into P REGISTER. Set RUN. Follow procedure from step 6 of Table 5-4. If malfunction recurs, prepare a new Binary Object paper tape by performing procedures in Table 5-3.
6		002	000	TAS is not first instruction of program. Malfunction occurs after intermediate pass.
	TTY prints TAS CARD NOT FOUND			Add TAS instruction to first line of program. If using 915 input, reload coding forms and ready 915. At 8092, set RUN STEP switch to center position. Set RUN.
		002	000	Checksum error occurs after Pass 2. Examine punched paper tape for damage and replace if required. Check alignment of paper tape in Paper Tape Reader. At 8092, set beginning address of Binary Loader into P REGISTER. Set RUN. Follow procedure from step 6 of Table 5-4. If malfunction recurs, prepare a new Binary Object paper tape by performing procedures in Table 5-3.

TABLE 5-5. ABNORMAL PROGRAM HALTS (CONT'D)

Step	Register Display P	A	Z	Procedure
7		003	000	Checksum missing. Malfunction occurs after Pass 2.
		004	000	Illegal special code occurs after Pass 2. Examine punched paper tape for damage and replace if required. Check alignment of paper tape in Paper Tape Reader. At 8092, set beginning address of Binary Loader into P REGISTER. Set RUN. Follow procedure from step 6 of Table 5-4. If malfunction recurs, prepare a new Binary Object paper tape by performing procedures in Table 5-3.
8	TTY prints FAILED TO LINE LOCATE	200	000	Check coding form for line locate bar and correct if necessary. Malfunction occurs after intermediate pass. At 915, load corrected coding form. At 8092, set RUN STEP switch to center position. Set RUN. Follow procedures from step at which program halt occurred.

SECTION 6

ABRIDGED OPERATING PROCEDURES

Abridged operating procedures for TAS are listed in Tables 6-1 through 6-4. The tables contain two columns. Numbers in the Step column indicate operating sequence. These numbers are identical to the step number listed in the corresponding table in Section 5 to enable quick reference to the detailed procedure. The Procedure column contains abridged actions to be performed and the results of these actions. Placard nomenclature is used when referring to the equipment controls and indicators. Equipment at which actions are performed are not listed unless the omission could cause confusion.

The Abnormal Program Halts table was not abridged and therefore possible abnormal program halts are referenced to Table 5-5.

TABLE 6-1. LOADING AND ASSEMBLING THE PROGRAM

Step	Procedure
1	Energize system.
2	Mount TAS tape with write ring. Set to Unit 3.
3	Set MASTER CLEAR.
	NOTE If 8092 does not have autoload, step 24.
4	Set LOAD, RUN. Halt, P=223. Set RUN to neutral.
5	Set MASTER CLEAR. Set RUN. Halt, P=6324, Z=077. Set RUN to neutral.
	NOTE If abnormal halt, Table 5-5.
6	Tape Transport to Unit 0.
7	Clear TAG REGISTER 1. Set TAG REGISTER 1=17. Set MASTER CLEAR.
	NOTE If 915 input, step 8. If Mod 33 TTY input, step 11. If Mod 35 TTY input, step 9.

Step	Procedure
8	Load TAS coding forms into 915. Press START. Go to step 12.
9	Set TTY MODE switch to TTR.
10	Key-in following patch: Storage / Content 531 / 132 534 / 135 541 / 164 Set P=467.
11	Set A=002.
12	Set RUN.
13	TAS tape to file 2.
14	Prints TAS PASS 1 and 915 READER INPUT or TYPEWRITER INPUT. If TTY input, type in program. Press ON (TTY Paper Tape Punch) or PUNCH POWER (8291 Paper Tape Punch).
15	Input written in scratch area. End of PASS 1, symbol table written on TAS tape.

TABLE 6-1. LOADING AND ASSEMBLING THE PROGRAM (CONT'D)

Step	Procedure
16	Binary Loader paper tape punched.
17	Data records from TAS tape read into memory.
18	Binary (object) program punched. Press OFF or PUNCH POWER.
19	TAS tape positioned to scratch area.
20	Listing printed.
21	Halt, A=110, Z=177. Set RUN to neutral. NOTE If abnormal halt, Table 5-5.
22	Dismount TAS tape and save for loading and re-start.
23	See Table 5-3 for loading and restart.
24	Key-in bootstrap if no autoload: Storage / Content 300 075 301 013 302 024 303 072 304 000 305 223 306 000

Step	Procedure
25	Set MASTER CLEAR. Set P=300. Set RUN. Halt, P=306, A=223, Z=000.
26	Set RUN to neutral. Go to step 5.

TABLE 6-2. LOADING AND ASSEMBLING THE PROGRAM WITH MAGNETIC TAPE INPUT

(To Be Supplied)

TABLE 6-3. LOADING AND RESTART ASSEMBLY

Step	Procedure
1	Energize system.
2	Mount TAS tape from step 22, Table 6-1. Set to Unit 3.
3	Set MASTER CLEAR. NOTE If 8092 does not have autoload, steps 24 and 25 of Table 6-1, then go to step 4. Set LOAD, RUN. Halt, P=223. Set RUN to neutral.
4	Set MASTER CLEAR. Set A=001. Set RUN. Halt, Z=077. NOTE If abnormal halt, Table 5-5. Set RUN to neutral.
5	Set Tape Transport to Unit 0.
6	Press ON (TTY Paper Tape Punch).
7	Clear TAG REGISTER 1. Set TAG REGISTER 1=001.

Step	Procedure
	Set MASTER CLEAR. Set RUN.
8	Binary Loader tape punched. Press OFF.
9	Halt, A=110, Z=177. Set RUN to neutral.
10	Output options, select one: Complete output listing, set RUN. Error lines listing, clear A, set A=000, set RUN. Octal fields listing, clear A, set A=011, set RUN. Octal fields and symbolic operation codes listing, clear A, set A=024, set RUN. Print fields listing, except comments, clear A, set A=041, set RUN. Punched paper tape output, clear A, set A=negative number, set RUN.
11	TAS tape positioned to data file.
12	Prints TAS PASS 2. NOTE If punched paper tape option is selected in step 10, press ON.

TABLE 6-3. LOADING AND RESTART ASSEMBLY (CONT'D)

Step	Procedure		
	Prints listing and punches tape. Press OFF.		
13	Halt, A=110, Z=177. NOTE If abnormal halt, Table 5-5.		
14	Repeat from step 10 for additional listings.		

TABLE 6-4. USING THE BINARY LOADER

Step	Procedure
1	Energize system.
2	Set MASTER CLEAR. Key-in Paper Tape bootstrap: NOTE Load bootstrap into bank zero. If using different bank, set bank number into TAG REGISTER 2 or 3. Reference bank at jump, P= 004. Storage / Content 000 075 001 036 002 005 003 076 004 060 005 000 006 141 007 000 010 172 011 001 012 376 013 164 014 000
3	CAUTION Set TAG REGISTER 1 to bank not used by assembled program. Clear TAG REGISTER 1. Set bank number into TAG REGISTER 1.
4	Mount Binary Loader and Object Program paper tape from steps 16 and 18, Table 6-1.
5	Set MASTER CLEAR and set RUN.
6	Set START (TTY) or press READER POWER (8299). Programs read in.
7	Halt, Z=077. NOTE If abnormal halt, Table 5-5.
8	TAS IDENT printed.
9	Set STOP (TTY) or press READER POWER (8299).
10	To load additional object programs, repeat from step 4.

CONTROL DATA
CORPORATION

OSAP CODING FORM

PAGE NO. ______
DATE ______
PROGRAMMER ______

PROGRAM ______
ROUTINE ______
PAGE ______

2 LOCATION	10 OP	15 ADDRESS	23 ADDITIVE	31 COMMENTS

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