

I. Ziller

Preliminary

Operator's Manual

April 8, 1957

THE FORTRAN  
AUTOMATIC CODING SYSTEM  
FOR THE  
IBM 704 EDPM

This manual describes the use of FORTRAN 4-1-4-1.

Programming Research Department  
International Business Machines Corporation  
590 Madison Ave., New York 22, New York

## PREPARING THE SYSTEM TAPE

Set the tape which is to become the FORTRAN System tape to logical 1, and load the system deck, the librarian, and the library routines at the 704 card reader. When the cards have gone in (correct final stop is 77777g) the system tape will have been written and is ready for use. The system tape should be File Protected.

(If later it is desired to change the library functions, the system itself need not be rewritten. Simply load the librarian followed by whatever functions the system tape is to have. Further details are given below in the section on Library Functions.)

Error Stops:	27g	Card check sum error.
	45g	Librarian failed to find correct end of permanent library.
	152g	Card check sum error.

## USING THE SYSTEM TAPE

Set the system tape to logical 1, and set two machine tapes to logical 3 and 4. If operating with off-line input, set the input tape (bearing the source program as the first file) to logical 2; otherwise set a machine tape to logical 2.

At the 704 card reader load the one-card FORTRAN system caller FNSC1, followed (if the input is on-line) by the source program deck. Do not use extra blank cards.

(If tape 1 is known to be rewound, FNSC1 is not necessary. With off-line input, simply press LOAD TAPE and when the card reader is selected, press START on the card reader. With on-line input, ready the source program in the card reader and press LOAD TAPE.)

Place the SHARE printer board #2 in the 704 printer.

Set the sense switches as follows:

Switch 1	UP to obtain the object program as a binary tape (Tape 4) <u>and</u> as a deck of binary cards.
----------	---

DOWN to obtain binary tape (Tape 4) only.

Switch 2 UP to produce on Tape 2 two files containing respectively the source program and a map of object program storage.

DOWN to add a third file to Tape 2, containing the object program in the language of the forthcoming modified SHARE symbolic assembly program.

Switch 3 DOWN to list on-line the first two or three files of Tape 2, depending upon whether switch 2 is UP or DOWN.

Switch 4 UP or DOWN to cause on-line listing to be single or double spaced.

The program ends by executing a load button sequence to the card reader. If the card reader is not ready, the machine will hang up at location 77775<sub>8</sub>; if it is ready but empty the machine will stop at 77777<sub>8</sub>.

## ERROR DETECTION

The FORTRAN system has provision for detecting a large number of source program and machine errors. On the final pages of this manual is a list of such errors, together with a brief characterization of the probable trouble and the recommended procedure.

Most of the detection of errors in the source program occurs in Section 1 of the system. For this reason, Section 1 has been equipped with an automatic diagnostic system which, instead of causing a stop, prints on-line the appropriate information about the trouble and then permits Section 1 to resume processing with the next source statement. Detection of an error covered by the diagnostic system does, however, prevent processing beyond Section 1; when such an error has occurred Section 1 ends with a stop at 77777<sub>8</sub> and processing cannot be continued.

The errors covered by the diagnostic system are flagged with an asterisk in the list at the end of this manual.

## RUNNING THE OBJECT PROGRAM

The binary deck which is produced when switch 1 is UP consists of the object program in relocatable binary, together with the four-card FORTRAN relocating loader UA CSB3 and appropriate control card and transfer card. The binary deck is thus ready for immediate loading and execution. For further details see the forthcoming SHARE write-up for UA CSB3.

Details about using the binary tape form of the object program will be announced later.

The printer board to be used with FORTRAN object program is SHARE #2.

## ERROR STOPS IN OBJECT PROGRAM

There are 9 standard error stops in object level input-output routines. They are to be recognized not by looking at the instruction counter but by looking at the HPR instruction itself in the storage register.

- |          |   |
|----------|---|
| HPR 0, 0 | End of file in reading binary tape. Press START to resume reading next file.  |
| HPR 0, 1 | End of file in reading cards or BCD tape. Press START to resume reading next file.  |
| HPR 1, 1 | Inappropriate character encountered in a data field in reading cards or BCD tape. Pressing START causes that character to be treated as a zero. |
| HPR 2, 1 |   |
| HPR 3, 1 |   |
| HPR 4, 1 |   |
| HPR 0, 2 | Non-Hollerith character encountered in reading card. Correct card, ready in card reader, and press START.                                       |
| HPR 0, 3 | Redundancy check in reading BCD tape. Press START to accept information read.   |
| HPR 0, 4 | Echo check in printing. Press START to continue. Press RESET and START to repeat line and continue.   |

**MAINTAINING THE  
LIBRARY FUNCTIONS**

Additions, deletions, and changes in the list of library functions can be made by means of the FORTRAN librarian FNLIB1. Each time it is used it rewrites completely the list of functions; hence it should be followed by all the routines which the system is desired to contain.

Each routine consists of one or more control cards, followed by the routine proper on relocatable binary cards. The routine proper must meet the specifications given on page 40 of the FORTRAN Programmer's Reference Manual.

The control cards are punched as if for loading by NYBL1. The loading address (9L address) must be zero, and the check sum must be given. The first control card has in its 8L address the number of locations occupied by the subroutine, and in its 8R address the 2's complement of  $n$ , where  $n$  is the length of the common storage region used by the routine. Succeeding rows have in the left word a function name (without the terminal F) followed if there is room by a blank character and zeroes in internal 704 BCD with the significant characters packed to the left, and in the address of the right word the corresponding entry point into the routine, relative to zero. For example, the control card for the UA S+C1 routine, which can calculate either cosine or sine by entering at relocatable 0 or 1, has COSb00 and 0 in its 7's row and SINb00 and 1 in its 6's row. If there are too many function names to fit on a single control card, they may be continued on additional control cards. On these additional cards do not repeat the information given in the 8's row of the first control card.

Any entry point which will cause the specifications for a library routine to be met can be given a function name (or several names if desired). Such names can be distinguished as primary or secondary names by not prefixing, or prefixing, the entry point with a minus sign (punch in column 37 of the appropriate row of the control card). The meaning of primary and secondary names arises out of the following rule of precedence which is used by the FORTRAN system in compiling library routines into the object program.

**RULE.** When a function is mentioned in a source program, the routine which will be used is the first routine on the system tape which meets either of the following conditions: (1) the name mentioned is a primary name of the routine; or (2) the name mentioned is a secondary name of the routine, and at least one of the primary names of the routine is also mentioned. (If no such routine exists, the universal empty routine HTR 1,4 is compiled.)

If the system tape is arranged with the routines which have many secondary names preceding the routines with few or none, this rule will prevent unnecessary duplication of routines in the object program. Suppose for example that the system tape contains an arc sine routine which also has an entry point which will compute a square root, and that this routine is given two names, ASINF (primary) and SQRTF (secondary). Suppose also that later on the tape is an ordinary square root routine with the single name SQRTF (primary). Then a source program which asks for both ASINF and SQRTF will cause compilation of the former program only.

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
27	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 1 (SYSTEM TAPE) MALFUNCTIONING	TAPE TO CORE STORAGE TO TAPE LOADER
36	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 4 MALFUNCTIONING	II
41	MACHINE ERROR-DRUM READ	START TO READ DRUM 3 MORE TIMES	CHECK SUM STOP IN READING DRUM 3	III-3
46	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	TAPE 2 NOT POSITIONED PROPERLY	III-1
47	MACHINE ERROR-DRUM READ	START TO READ DRUM 3 MORE TIMES	CHECK SUM STOP IN READING DRUM 3	III-2
55	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	ILLEGAL END OF FILE ON TAPE 2	III-1
62	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 3 MALFUNCTIONING	II
63	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 3 MALFUNCTIONING	II
64	MACHINE ERROR-TAPE CHECK	START TO READ 3 MORE TIMES	ERROR IN READING TAPE 2	III-1
65	MACHINE ERROR	PRESS START TO REREAD	ERROR READING FROM DRUM 1	IV-5
66	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 3 MALFUNCTIONING	II
66	MACHINE ERROR	PRESS START OR GET OFF	TAPE CHECK, TAPE 2	II
67	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 3 MALFUNCTIONING	II
72	MACHINE ERROR	PRESS START TO TRY AGAIN	TAPE 3 MALFUNCTIONING	II
72	MACHINE ERROR-DRUM READ	START TO READ DRUM 3 MORE TIMES	CHECK SUM STOP IN READING DRUM 3	III-3

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
			PROGRAM	
355	MACHINE ERROR	RECOMPILE	NO ENTRY IN TIFGO FOR ASSIGNED GO TO	IV-2
357	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	TAPE 2 NOT POSITIONED PROPERLY	III-2
357	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-3
357	SOURCE PROGRAM	GET OFF MACHINE	A DO STATEMENT CONTAINS A STATEMENT NUMBER WHICH DOES NOT APPEAR IN COLUMNS 1 TO 5 IN SOURCE PROGRAM	I PRIME
365	MACHINE ERROR	START TO IGNORE	LIBRARY FUNCTION NAME LOST FROM TABLE	VI
366	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	ILLEGAL END OF FILE ON TAPE 2	III-2
375	MACHINE ERROR-TAPE READ	START TO READ TAPE 3 MORE TIMES	ERROR IN READING TAPE 2	III-2
401	POSSIBLE MACHINE ERROR	START TO IGNORE	UNDEFINED SYNONYM	VI
410	MACHINE ERROR-TAPE READ	START TO READ TAPE 3 MORE TIMES	ERROR IN READING TAPE 4	III-2
412	SOURCE PROGRAM	GET OFF MACHINE	DISPLAY LOCATION (405)8. THE NUMBER IN THE ADDRESS FIELD SHOULD APPEAR IN THE FOLLOWING TABLE ADDR MEANING 433 MORE THAN 100 DIFFERENT FIXED POINT CONSTANTS IN SOURCE PROGRAM. SEE P44, PAR2 OF FORTRAN MANUAL 442 MORE THAN 450 DIFFERENT FLOATING POINT CONSTANTS IN SOURCE PROGRAM. SEE	I



STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
	TAPE POSITIONING		ERROR ON TAPE 3	
425	MACHINE ERROR	RECOMPILE	IMPOSSIBLE DIVIDE CHECK	IV-6
427	MACHINE ERROR-TAPE READING	START TO READ TAPE 1 MORE TIME	ERROR IN READING TAPE 2	III-1
430	MACHINE ERROR-TAPE READ	START TO READ TAPE 3 MORE TIMES	ERROR IN READING TAPE 4	III-2
430	SOURCE PROGRAM	CORRECT SOURCE PROGRAM	PROGRAM TOO COMPLEX, SIMPLIFY OR DO IN 2 PARTS (TOO MANY BASIC BLOCKS)	IV-1
434	POSSIBLE MACHINE ERROR	START TO IGNORE	ILLEGAL LOCATION SYMBOL	VI
437	MACHINE ERROR-TAPE READING	START TO READ TAPE 1 MORE TIME	ERROR IN READING TAPE 4	III-1
437	MACHINE ERROR	PRESS START TO TRY AGAIN	REDUNDANCY TAPE CHECK (TAPE 3), SECTION 5-2	V-2
441	POSSIBLE MACHINE ERROR	START TO IGNORE	UNDEFINED SYNONYM	VI
442	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-3
446	MACHINE ERROR-TAPE READ	START TO READ TAPE 3 MORE TIMES	ERROR IN READING TAPE 4	III-2
451	MACHINE ERROR	RECOMPILE	IMPOSSIBLE END OF FILE ON TAPE 2	IV-1
455	SOURCE PROGRAM	CORRECT SOURCE PROGRAM	PROBABLY DUE TO A PART OF THE SOURCE PROGRAM WHICH HAS NO POSSIBLE PATH OF FLOW TO IT. ALSO MAY BE DUE TO DUPLICATED EXTERNAL FORMULA NUMBERS, DEFINITION OF A FORTRAN FUNCTION IN THE MIDDLE OF THE SOURCE PROGRAM, OR OTHER SOURCE PROGRAM ERRORS	IV-2

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
		TRY AGAIN	(TAPE 3) IN SECTION 5-1	
1353	MACHINE ERROR- TAPE POSITION- ING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-1
1611	MACHINE ERROR- TAPE POSITION- ING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-1
1640	MACHINE ERROR	GET OFF MACHINE	LOOP EXIT FAILED, SECTION 5-1	V-1
1647	MACHINE ERROR	GET OFF MACHINE	IMPOSSIBLE DIVIDE CHECK	V-1
2003	MACHINE ERROR	GET OFF MACHINE	LOOP EXIT FAILED, SECTION 5-1	V-1
2023	SOURCE PROGRAM	GET OFF MACHINE	DISPLAY INDEX B	I PRIME

INDEX B MEANING

- 1 MORE THAN 1500 STATEMENT NUMBERS IN SOURCE PROGRAM. SEE P44, PAR1 OF FORTRAN MANUAL
- 2 MORE THAN 150 DO STATEMENTS (INCLUDING THOSE PRODUCED BY INPUT OUTPUT STATEMENTS) IN SOURCE PROGRAM. SEE P44, PAR4 OF FORTRAN MANUAL
- 3 THE NUMBER OF ASSIGN STATEMENTS PLUS IF TYPE AND GO TO TYPE STATEMENTS EXCEEDS 300. SEE P44, PAR6 OF FORTRAN MANUAL
- 4 THE TOTAL NUMBER OF STATEMENT NUMBERS MENTIONED IN ASSIGNED GO TO AND COMPUTED GO TO STATEMENTS EXCEEDS 250. SEE P44, PAR7

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
------	---------------	------------	------------------	---------

## INDEX B MEANING

- |    |  |  |  |  |
|----|--|--|--|--|
| 4  | OF FORTRAN MANUAL<br>THE TOTAL NUMBER<br>OF LITERAL APPEAR-<br>ANCES OF SUB-<br>SCRIPTED VARI-<br>ABLES EXCEEDS 1000<br>SEE P45, PAR16 OF<br>FORTRAN MANUAL  |  |  |  |
| 5  | THE TOTAL NUMBER<br>OF LITERAL APPEAR-<br>ANCES OF NON-SUB-<br>SCRIPTED FIXED<br>POINT VARIABLES<br>ON THE RIGHT HAND<br>SIDE OF ARITHMETIC<br>FORMULAS AND IN<br>THE ARGUMENT OF<br>IF,S EXCEEDS 750<br>SEE P45, PAR15 OF<br>FORTRAN MANUAL |  |  |  |
| 6  | THE NUMBER OF<br>ARITHMETIC FORM-<br>ULAS WHOSE LEFT<br>HAND SIDES ARE<br>NON-SUBSCRIBED<br>FIXED POINT VARI-<br>ABLES EXCEEDS 500.<br>SEE P45, PAR 14 OF<br>FORTRAN MANUAL  |  |  |  |
| 7  | NUMBERS MENTIONED<br>IN FREQUENCY<br>STATEMENTS EXCEEDS<br>750. SEE P44, PAR<br>8 OF FORTRAN<br>MANUAL   |  |  |  |
| 8  | THE NUMBER OF<br>LITERAL APPEAR-<br>ANCES OF VARIABLES<br>IN EQUIVALENCE<br>STATEMENTS EX-<br>CEEDS 750. SEE<br>P44, PAR10 OF<br>FORTRAN MANUAL  |  |  |  |
| 9  | THE NUMBER OF<br>LITERAL APPEAR-<br>ANCES OF FUNCTIONS<br>EXCEEDS 1500.<br>SEE P45, PAR13 OF<br>FORTRAN MANUAL   |  |  |  |
| 10 | TOO MANY CHAR-   |  |  |  |

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
	PROGRAM		SCRIPT	
6243	MACHINE ERROR	GET OFF MACHINE	ERROR CONCERNING DUPLICATE SUBSCRIPT COMBINATIONS	II
* 6250	SOURCE PROGRAM	START	SUBSCRIPT MULTIPLIER IS NOT A CONSTANT	I
* 6264	SOURCE PROGRAM	START	DOUBLE ADDEND FOR SUBSCRIPT	I
* 6267	SOURCE PROGRAM	START	SUBSCRIPT IS NOT A FIXED POINT VARIABLE	I
6326	MACHINE ERROR	START	WRONG CHECK SUM FROM DIM1 TABLE	I
6356	MACHINE ERROR	START	WRONG CHECK SUM FROM DIM2 TABLE	I
6357	MACHINE ERROR	PRESS START OR GET OFF MACHINE	CHECK SUM ERROR, DRUM READ (DRUM 2)	II
6367	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-1
6373	MACHINE ERROR	GET OFF MACHINE	A FLOW SCAN OF DOTAG IS INCORRECT	II
6376	MACHINE ERROR	GET OFF MACHINE	A FLOW SCAN OF DOTAG IS INCORRECT	II
6405	MACHINE ERROR	START	WRONG CHECK SUM FROM DIM3 TABLE	I
6423	MACHINE ERROR	GET OFF MACHINE	A FLOW SCAN OF DOTAG IS INCORRECT	II
6431	SOURCE PROGRAM	GET OFF MACHINE	TOO MANY DO'S END AT SAME FORMULA. REWRITE SOURCE PROGRAM AND SEPARATE DO'S BY USING CONTINUE STATEMENTS.	II
6432	SOURCE PROGRAM	GET OFF MACHINE	A VARIABLE PARAMETER OF A DO IS REDEFINED BY ANOTHER DO WITHIN THE RANGE OF THE FIRST DO	II
6436	MACHINE ERROR-TAPE POSITIONING	GET OFF MACHINE	PROBABLE TAPE POSITIONING ERROR ON TAPE 2	III-1

STOP	KIND OF ERROR	WHAT TO DO	DETAILS OF ERROR	SECTION
		GET OFF MACHINE		
7073	MACHINE ERROR	GET OFF MACHINE	DUPLICATE INTERNAL FORMULA NUMBERS	II
7075	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7076	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7103	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7110	MACHINE ERROR	GET OFF MACHINE	A TABLE SORT WAS NOT CORRECT (TAVLE IRV)	II
7112	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7123	MACHINE ERROR	PRESS START OR GET OFF MACHINE	TAPE CHECK, TAPE2	II
7133	MACHINE ERROR	GET OFF MACHINE	CHECK SUM ERROR IN READING DIM2 FROM DRUM 3 COMPUTED CHECK SUM IN LOCATION (7402)8. READ IN CHECK SUM IN LOCATION (7401)8	I PRIME
7135	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7140	MACHINE ERROR	GET OFF MACHINE	DIVIDE CHECK IN COMPUTING DIM3 WORD COUNT	I PRIME
7211	MACHINE ERROR	GET OFF MACHINE	CHECK SUM ERROR IN READING DIM3 FROM DRUM3 COMPUTED CHECK SUM IN LOCATION (7404)8. READ IN CHECK SUM IN LOCATION (7403)8	I PRIME
7250	MACHINE ERROR	GET OFF MACHINE	TAPE POSITION ERROR, TAPE2	II
7303	MACHINE ERROR	GET OFF MACHINE	DIVIDE CHECK IN COMPUTING SIZ WORD COUNT	I PRIME
7303	SOURCE	GET OFF MACHINE	A TABLE IS FULL. SOURCE PROGRAM HAS TOO MANY DISTINCT PURE RELATIVE CONSTANT SC (TABLE IRV)	II
7334	MACHINE ERROR	GET OFF MACHINE	IMPOSSIBLE DIVIDE CHECK	V-1
7351	MACHINE ERROR	GET OFF MACHINE	IMPOSSIBLE DIVIDE CHECK	V-1