WANG

THE DISK SORT UTILITY

The Disk Sort Utility

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HOW TO USE THIS MANUAL

This manual describes the use of the Disk Sort Utility which utilizes the Sort Statements for rapid execution. It assumes that the reader is familiar with the operation of his system, the available disk unit and has access to:

the BASIC Reference Manual
the BASIC Programming Manual
the Disk Memory Reference Manual.

Advanced programmers who wish to use the Sort Statements directly should refer to the Sort Statements manual.

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SUMMARY

The Disk Sort Utility has been prepared to enhance and make more effective the disk sorting capabilities of your Wang system. The utility uses Sort statements and can be run on any of the Wang family of disk units (Models 2240, 2242, 2243, 2230, 2260). The program is stored for transmittal to the user on a tape cassette; it must be copied to a disk before being run. Part of the procedure used for copying the program to a disk includes modifications to tailor the program to the specific equipment configuration used. In addition to the usual input and output files, the program requires that a "sort-work file" be specified; this is an interim file used by the program for storing intermediate results. All three of these files must be unique. The program file and all the data files must be mounted at the start of each program run and all must remain mounted until its end.

Depending upon the size of the records to be sorted and the available machine configuration, either a full-record or key sort is performed. The choice of which type of sort to perform is made by the program. In general, with short records, a full-record sort is faster than a key sort. In a full-record sort the entire input record is reformatted so that the record can be efficiently moved. When the sort and merge operations take place the entire input record is used. After all records have been sorted on the final merge pass, the records are reformatted to the input format before being written out on the output file.

In a key sort, only the sort key is extracted from each input record and carried, with a pointer to the input record, as the sort record. The sort records are sorted internally and are used to form sorted strings which are merged until all records have been used. At the end of program execution, the sort records are read in order, the appropriate input records are found (with the pointers) and the output file is created. This method will generally be used if the file is too large to be sorted in a single pass, given the size of the sort records and the amount of memory available for sort buffers; for example, with long records and when the record length is more than twice as long as the sort key length.

The optimum number of records per block is 129 because MAT SORT executes fastest with an array length of one greater than a power of 2 (block length = row length in a merge array). In most cases it is faster to do a sort/merge operation than to perform a sort only on a very large array. However, if the total number of sort records is less than 255, no merge operation is done and in pass 1 the sort is performed using an array with row length equal to a multiple of block size.

The sort key can contain up to ten fields; its total length must not exceed 64 bytes. Sort order can be specified for each field of the sort key, either ascending or descending in each field.

The Disk Sort Utility runs in three or four phases, depending on whether it is performing a full-record or a key sort:

1. accept input specifications, generate code

2. perform internal sort (pass 1)

3. perform merge (if full-record sort, write output file) [pass 2]

4. (if key sort, write output file). [pass 3]

The phases are further described in the Operating Instructions.

THE INPUT FILE

The input file must conform to the following specifications:

1. be written in disk catalogue mode (using DATASAVE DC OPEN, DATASAVE DC END and DATASAVE DC CLOSE).

2. have all records in the same format (no special header or trailer records, no variable length records).

3. have either blocked or unblocked records.

   a. if unblocked, have not more than 55 fields per record.

   b. if blocked (i.e., written in array form !DIM A$(4)3, B(4), C$(4)20 : DATASAVE DC #n, A$(), B(), C$()1)

      i. have not more than 38 fields per record.

      ii. have not more than 255 records per block.

      iii. have all blocks filled (unused records in the last block must be filled with padding records that will sort high if to be used in an ascending sort, or low, if to be used in a descending sort).

4. Have all records on a single disk platter.

THE OUTPUT FILE

The output file is also a catalogued file; its name must be specified by the user during the initial phase of program running. If the input file is blocked, the output file will automatically be blocked in the same manner. The output file can either have been previously catalogued by the user, or the user can allow the program to catalogue it for him.

THE SORT-WORK FILE

The length of the sort-work file will not generally exceed the length of the input file; its actual length is calculated by the program before beginning sorting operations. The user is informed (an error message appears on the CRT) if there is insufficient space on disk for this file. The maximum length of the sort-work file when doing a full-record sort can be estimated by evaluating the following expression:

$$W = 2I\left(\frac{L+8N}{L}\right) + 25$$

where W = sectors in the sort-work file
I = sectors in the input file
L = bytes per record
N = number of numeric sort-key fields.

The maximum length of the sort-work file when doing a key sort can be estimated by evaluating the following expression:

$$W = 2I\left(\frac{K+5}{L}\right) + 25$$

where W, I and L are as defined above and

K = bytes in the sort key.

These estimates are only approximate because the expressions given are greatly abbreviated from the algorithms actually used in the program. In general it is best to let the program calculate a more exact value for you. Actual sort-work file space required by the program can be up to 50% less than these formulas would indicate. For exceptionally large files or where disk space is scarce, a more exact value may be needed. In such a case, be sure to use the program to do the calculation for you. (See Part C "Creating Space for the Sort-Work File" in the next section.)

OPERATING INSTRUCTIONS

Before the Disk Sort Utility can be run, its first module must be modified according to the available system configuration, the program must be copied onto a disk, and space for the sort-work file must be allocated. These instructions are thus separated into four sections:

A. loading and modifying the first program module

B. copying the modified module and the remaining program modules onto a disk

C. creating space for the sort-work file

D. running the program.

A. Load and Modify Procedure

1. Mount the program tape in the console tape unit (10A).

2. Load the first module (CLEAR, LOAD "DSM200AA").

3. Change the following three program lines according to the system you have:

line no.	contents	used in tape program
480M	= (memory size in K-bytes)	[M=8]
490D	= (disk size in sectors per platter)	[D=9792]
495	SELECT #4 (disk for program)	[310]

M can be 8, 12, 16, 20, 24, 28 or 32K bytes;
D can be from 512 to 19584 sectors (see Table 3.1);
The SELECTed unit can be either 310 (fixed/left), B10 (removable/right), or 350 for the third platter of a triple floppy.

Table 3.1

Sectors Per Platter

Disk Model	Number of Sectors Per Platter
2240-1	512
2240-2	1024
2242	1024
2243	1024
2230-1	2400
2230-2	4800
2230-3	9792
2260	19584

B. Copy Procedure

1. Mount the disk platter on which you will record the program in the unit specified in Step A3.

2. Save the first program module by entering and executing the following statement:

```
SAVE DC platter $ "name"
```

Where platter = F, R or T

"name" = DSM200AA or any name you wish to use. The name must be within double quotes (").

> Note:
>
> It is only permissable to change the name of this first module. All other modules are called internally by the Disk Sort Utility; their names must not be changed.

3. Copy the remaining six modules from tape to disk:

```
CLEAR
LOAD "DSM200BA"
SAVE DC platter $"DSM200BA"

CLEAR
LOAD "DSM200CA"
SAVE DC platter $"DSM200CA"

CLEAR
LOAD "DSM201AA"
SAVE DC platter $"DSM201AA"

CLEAR
LOAD "DSM202AA"
SAVE DC platter $"DSM202AA"

CLEAR
LOAD "DSM202BA"
SAVE DC platter $"DSM202BA"

CLEAR
LOAD "DSM203AA"
SAVE DC platter $"DSM203AA"
```

4. Rewind and remove the program tape.

C. Creating Space for the Sort-Work File

An area on one of the available disks must be set aside to accommodate the sort-work file. This file can either be set up as a catalogued file or it can be placed in a temporary work area folloing the last catalogued sector on the available disk.

To create a catalogued sort-work file, enter:

```
DATASAVE DC OPEN platter sectors, "name"
```

Where: platter = F, R or T/350
sectors = the number of sectors to be reserved
name = the name of the sort-work file.

To use the uncatalogued area on an available disk, use the MOVE END instruction to move the boundary between the catalogued and uncatalogued area, or use the SCRATCH DISK instruction (see your Disk Reference Manual for further information on these two instructions).

In either case, you must estimate the size of the sort-work file to determine how many sectors are needed for it. A rough estimate can be obtained by using the expressions in Section "The Sort-Work File"; a more accurate estimate can be made by using the first module of the program. To use the program for this purpose you must have an input file, either the actual file you wish to sort or a dummy file which has records of the same format as the file you wish to sort.

1. To create a dummy catalogued file containing at least one record or block of records in the format of the file to be sorted enter the following lines into **your system:**

```
10 DIM array names and sizes
20 DATASAVE DC OPEN platter sectors, "name"
30 DATASAVE DC (write record or block)
40 DATASAVE DC END
50 DATASAVE DC CLOSE
```

The dimensions of arrays or variables and the names used to write the record or block must coincide with those of the actual file to be sorted. The number of sectors must equal the record length (in sectors) +2. The object of entering and executing this routine is to create a dummy file of the correct format; the format is then analyzed by the Disk Sort Utility to determine field length, length of sort-work file, etc.

2. Set up a sort-work file of at least 25 sectors (enter and execute a line such as DATASAVE DC OPEN R 300, "SRTWRK")

3. Load the first module of the Disk Sort Utility into memory.

```
CLEAR
LOAD DC F "DSM200AA"
```

4. Add the following statements to the program in memory:

```
4015 STOP "NOW AT LINE 4015"
4075 STOP "NOW AT LINE 4075"
```

5. Run the program entering the input specifications as if you are to do a normal sort.

6. When the program displays "STOP NOW AT LINE 4015" on the CRT, enter the number of records to be sorted into memory by keying in L1 = number of records to be sorted.

7. Touch CONTINUE
   RETURN(EXEC) to resume program execution.

8. When the CRT displays "STOP NOW AT LINE 4075" obtain the size of the sort-work file in sectors by entering (in immediate mode) and executing

```
PRINT 15 + Z + Q8
```

15 is the number of sectors for generated code.
Z is the number of sectors required for the string index created by the Sort.
Q8 is the number of sectors required for sort records.

The number displayed is the size of the sort-work file in sectors. Other variables calculated by the program which can be interrogated at this stage in immediate mode are:

Variable	Contents
B	sectors/block in sort blocking
D2	records/block in sort blocking
D3*D9	records/sorted string in Pass 1
D6	"power" of the merge in Pass 2
K	sort key length
L3	sort record length
S	sectors available in the sort-work file
T1$	if K, a key sort will be done; if R, a full-record sort.

Since the program will decide whether to do a key sort or a full-record sort, the user can verify which is to be done by interrogating T1$. If the program decides to do a full-record sort, then the full-record sort will be faster than a key sort. However, a full-record sort requires more sort-work file space. If there is insufficient room to do a full-record sort, the program reverts to a key sort. If there is insufficient room to do a key sort, the program displays "WORK FILE SPACE TOO SMALL" when it is run.

If the amount of work file space needed is more than is available on the disk and a key sort is indicated, you must break up your input file if you are to sort it with the Disk Sort Utility (see Section D). If a full-record sort is indicated, it is possible that the file can still be sorted in the available space by doing a key sort (see step 10).

9. To recalculate the size of the sort work file for other files of the same format but of different sizes, enter:

```
RUN 4015
RETURN(EXEC)
```

and return to Step 6.

10. If the variable T1$ is "R" indicating a full-record sort, the user can ascertain how much sort-work file space is needed for a key sort. To do this, enter:

```
RUN 3190
RETURN(EXEC)
```

and return to Step 6.

11. To calculate sort-work file space for another file in another format enter:

```
RUN
RETURN(EXEC)
```

and return to Step 1.

> Note:
>
> Do not continue program execution beyond this step since once variables in the program have been modified, results of the sort itself can be unpredictable.

D. Running the Disk Sort Utility

Before running the program be sure to have it recorded on the appropriate disk (see Part A, above) and have your input, output and sort-work file platters also in the disk unit. The input file is the file to be sorted; the output file, a catalogued file containing the sorted output. The sort-work file is an interim file used in the sort process; it is further described in Part C, above.

You must know the following before beginning program execution:

1. the input file name

2. the platter (unit) which it is on

3. the number of records per block

4. the starting record number to be sorted

5. the number of records to be sorted (or all)

6. the number of key fields on which to sort (no more than 10)

7. the sequence number of each key field

8. whether the sort is to be ascending or descending

9. the sort-work file name.

The input file name, the platter it is on and the number of records/block are normally established when setting up the initial file to be run. The starting record number and number of records to be sorted depend on the available equipment configuration and the size of the input file. The key fields and their sequence numbers can be established as follows: say your records contain the four fields:

A$ = account no.
N$ = name
S$ = address
Z$ = zip code

the sequence number of each field is:

field name	sequence no.
A$	1
N$	2
S$	3
Z$	4

To sort on zip code and name, the number of keyfields is 2, and the sequence numbers of these two fields are 4 (keyfield #1, the zip code) and 2 (keyfield #2, name).

Normally:

STARTING RECORD NUMBER TO BE SORTED = 1
NUMBER OF RECORDS TO BE SORTED = "ALL"

The option to specify a different starting record and number of records is designed for use where the file is too large to be sorted all at once, for example the input file occupies 7000 sectors, the output file requires 7000 sectors, and the work file requires, say, 5000 sectors. Each of these files must be wholly contained on a disk platter. Given 9792 sectors on a disk platter, there is no way that these three files can be accommodated.

But half the file can be sorted by using records 1 to 3500. The work space required will then be about 2500 sectors and the work file and input file will both fit on the same disk platter (9792=7000 = 2792). The procedure to sort the whole file is as follows:

Sort the first half:

```
STARTING RECORD = 1
NUMBER OF RECORDS = 3500
OUTPUT FILE = "OUTPUT 1"
```

Sort the second half:

```
STARTING RECORD = 3501
NUMBER OF RECORDS = "ALL"
OUTPUT FILE = "OUTPUT 2"
```

Merge the two halves:

The user must write a program to merge "OUTPUT 1" and "OUTPUT 2" to produce the final sorted output. If "OUTPUT 1" and "OUTPUT 2" are both on the same platter, then the input platter can be removed and a scratch disk mounted for the final merged output.

> Note:
>
> For merge operations it can be useful to utilize the powerful **operations available with the MAT MERGE statement. See the Sort Statements Reference Manual.**

DISK SORT UTILITY — [¢] = touch the RETURN(EXEC) key

Entry	Display	Notes
1. CLEAR [¢]	CLEAR	The light in the unit containing the program disk must be lit.
2. LOAD DC platter "name" [¢]	LOAD DC - "_ _ _ _ _ _ _ _"	Platter can be F (left) or R (middle or right); name can be DSM200AA or as specified previously. The first program module is loaded. If ERR 72 occurs return to Step 1. If ERR 80 occurs, check your setup, return to Step 1.
3. RUN [¢]	RUN :_	
4.	DISK SORT - ENTER SPECIFICATIONS	
5.	INPUT FILE NAME?	
6. file name [¢]	_ _ _ _ _ _ _ _	The input file must be a catalogued disk file; if "RE-ENTER" is displayed you have input too many characters.
7.	INPUT PLATTER (F OR R)?	F = fixed, R = removable or 3 for third platter of a triple floppy. Note: The prompt asks for only F or R, but all three responses are valid. If ERR 72 occurs, rerun from step 1; if ERR 80 occurs, rerun from step 2 using correct file name and platter.
8. platter [¢]		If RE-ENTER is displayed, repeat step 7; if INPUT INVALID is displayed, your input platter is not a data file; otherwise stop and recheck your input file and program modifications.
9.	RECORDS PER BLOCK?	
10. records/block [¢]		Enter 1 if records are not blocked. If RE-ENTER is displayed the value you have entered is out of range, enter a correct value; if ERR 29 is displayed you have not entered a numeric value, enter a number; if INVALID is displayed you have entered a value less than 1 or greater than 255, the number of records/block must be within these limits.
11.		The module determines record or block format and checks the blocking specified in step 10. If STOP TOO MANY FIELDS is displayed, there are more than 38 fields/record (blocked) or 55 fields/record (unblocked) in the input/file; the program cannot sort this file. If STOP INVALID RECORD FORMAT is displayed the program cannot sort this file. If STOP NOT BLOCKED AS SPECIFIED is displayed, the value input in step 10 is inconsistent with the actual file format; either rerun from step 3 or stop (if blocking was not done in array form; in this case the program cannot sort the file).

DISK SORT UTILITY	[¢] = touch the RETURN(EXEC) key	
Entry	Display	Notes
12.	STARTING RECORD # TO BE SORTED?	For some large files, the sort must be performed by first sorting small groups and then doing a merge. To sort the entire file, enter 1; to sort the file in parts, enter the number of the first record to be sorted.
13. record # [¢]	_	If RE-ENTER is displayed, you have entered too large a value - re-enter a correct number; if ERR 29 is displayed you have not entered a number, enter a correct value; if INVALID is displayed you have entered a value less than 1, enter a correct value.
14.	NUMBER OF RECORDS TO BE SORTED (OR ALL)?	A specific number of records can be sorted, or the entire file can be sorted. To sort the entire file enter ALL; to sort a group of records, enter the number of records.
15. number of records [¢]		IF RE-ENTER, INVALID or ERR 29 is displayed you have entered an incorrect value; enter a correct number (or ALL). If STOP INVALID RECORD FORMAT is displayed, the program cannot sort the input file; you must use another file and return to step 1. If STARTING RECORD TOO HIGH is displayed you entered a number greater than the number of records in the file; return to step 12.
16.	NUMBER OF KEY FIELDS (1 to 10)?	
17. number of fields [¢]		If RE-ENTER, INVALID or ERR 29 are displayed you have entered an incorrect value; enter a correct one.
18.	ENTER SEQUENCE NUMBER OF KEY FIELD IN RECORD	
19. sequence # [¢]		If RE-ENTER, INVALID or ERR 29 are displayed you have entered an incorrect value; enter a correct one. If STOP SORT KEY TOO LONG is displayed, the sort key fields exceed 64 bytes total; this is outside program limits and the program cannot run with these fields.
20.	KEY FIELD--ASCENDING OR DESCENDING (A OR D)? ? _	This prompt and step 18 appear for each key field; both must be answered for each key field. Ascending sort is low to high; descending, high to low. For an ascending sort you can touch the RETURN(EXEC) key alone. If RE-ENTER is displayed you have not entered A or D.
21. A or D [¢]		

DISK SORT UTILITY — [¢] = touch the RETURN(EXEC) key

Entry	Display	Notes
22.	WORK FILE NAME:	The sort-work file has either been named in Part C above or is in the uncatalogued (TEMP) area. If the latter, touch RETURN(EXEC); otherwise, input the file name.
23. name [¢]		If RE-ENTER is displayed your file name is too long; enter a correct name.
24.	WORK FILE PLATTER (F OR R)?	
25. platter [¢]		IF RE-ENTER IS DISPLAYED YOU HAVE not entered F or R; if DUPLICATE FILE is displayed you have used the same file name and platter twice; if WORK SPACE TOO SMALL is displayed you must either change your answer to step 22 or 24, create a new work file or re-modify the program for platter size. In the latter case return to step 3 (RESET; SELECT PRINT 005, CO 005 ¢). If STOP NO ROOM TO SORT is displayed, the input/output record size is too large to be sorted in available memory (or line 480 has n less than 8). The program cannot sort this file. If ERR 72 or ERR 80 is displayed you must return to step 2.
26.	OUTPUT FILE NAME:	Name the output file of sorted data.
27. name [¢]		If RE-ENTER is displayed you have entered too many characters.
28.	OUTPUT PLATTER (F OR R)?	Indicate the output platter.
29. platter [¢]		If RE-ENTER is displayed you have either not entered F, R or 3 or have entered too many characters. If DUPLICATE FILE IS displayed, you have used the same file name and platter twice.
30.	IS OUTPUT FILE CATALOGUED? (Y OR N)	The program normally catalogues each output file automatically; it will not do so if the file is already catalogued and this prompt is answered "Y". The Sort program catalogues the amount of space required; if more space is needed the file must be catalogued in advance (DATASAVE DC OPEN platter, sectors, name). If 'Y' is entered and ERR 80 is displayed, the file has not been found; if OUTPUT SPACE TOO SMALL is displayed you must repeat step 26 with a new output file name. If 'N' is entered and ERR 79 is displayed, the file has already been catalogued. If ERR 72 or ERR 85 is displayed you must rerun from step 1. If RE-ENTER is displayed you have not entered Y or N.

Entry	Display	Notes
31. Y or N ¢		
32.		The program proceeds without further operator intervention and displays messages as various passes progress. If in any pass ERR 72, ERR 80 or ERR 85 occurs, you must rerun from step 1.
33.	PASS 1 - INTERNAL SORT	If ERR 43 occurs, the input file is not all of the same format and cannot be sorted.
34.	PASS 2 - MERGE	If STOP SEQUENCE ERROR is displayed the program must be rerun from the beginning.
35.	PASS 3 - OUTPUT	This step is omitted if a key sort has been done. If STOP SEQUENCE ERROR is displayed you must rerun from step If this error persists even when rerunning, call your Wang Service office.
36.	INPUT RECORDS _ _ _ _ _ OUTPUT RECORDS _ _ _ _ _ STOP END OF SORT	

APPENDIX: Disk Sort Utility Timing

The time that it takes for the Disk Sort Utility to sort an array depends largely on whether a record sort or a key sort is done. Actual sort times depend on the number of records to be sorted, the size of each record, the length and position of the sort key in the record and the amount of available RAM (random-access memory) in the CPU. In Table and Figure 1 approximate empirically-determined times for sorting sample data files using the Disk Sort Utility are given; the Model 2230-3 disk was used.

Table 1. Approximate Disk Sort Utility Times

Available RAM (bytes)	No. of Records To Sort	Record/Key Length (bytes)	Type (R=record, K=key)	Sort Time (minutes)
8K	1000	120/8	K	7.8
8K	1000	120/64	K	12.3
8K	4000	24/24	R	17.5
8K	20,000	24/24	R	92.0
32K	1000	120/8	K	7.3
32K	1000	120/64	R	9.2
32K	2000	24/24	R	7.0
32K	4000	128/8	K	28.8
32K	4000	120/64	R	41.6
32K	8000	24/24	R	27.3

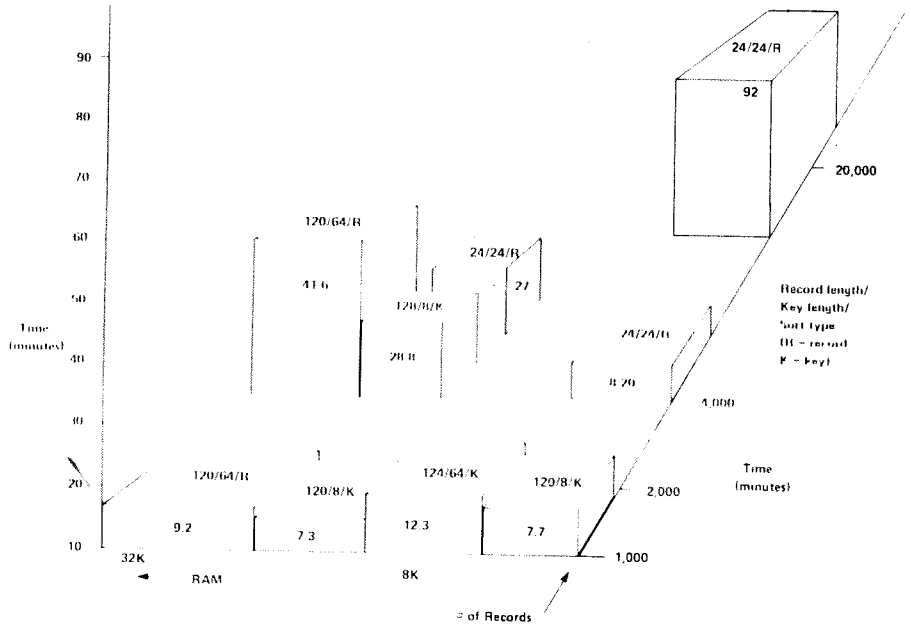

Figure 1. Approximate Disk Sort Utility Times

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