WANG

2228/2780 EMULATION UTILITIES USER MANUAL

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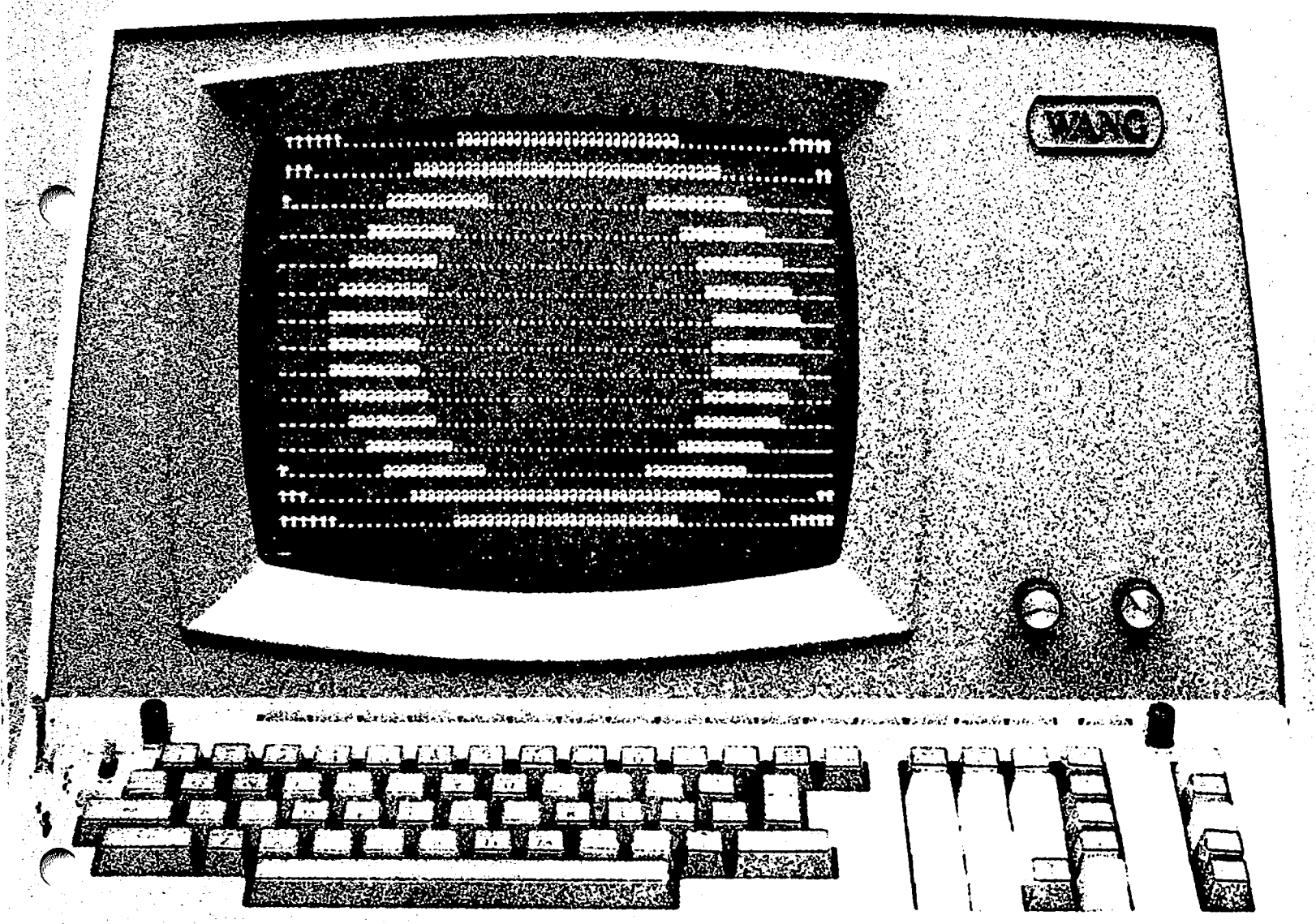
SYSTEM 2200



2228/2780 EMULATION UTILITIES USER MANUAL

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PREFACE

Wang's IBM 2780 Emulation Utilities Package for the Model 2228 Communications Controller may be obtained on a Model 2270-type diskette, a Model 2240-type flexible disk, or as a disk image on cassette package for systems with hard disks only. The disk image on cassette version must be copied to a disk before use, as described in Appendix D. Package numbers for all three media are as follows:

Model 2240-type flexible disk	195-0022-2
Model 2270-type diskette	195-0022-3
Disk image on cassette	195-0022-7

The version received should be checked to determine its compatibility with the peripherals in the Wang system being used for communications applications.

Chapter 1 presents an overview of the Model 2228 Communications Controller and the currently available utility programs associated with the controller.

Chapters 2 and 3 describe the 2780 Emulation Utilities Package and give operating instructions.

Readers of this manual should be familiar with the Wang system, in general, and the particular peripherals to be used for data transmission and reception.

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CHAPTER 1
OVERVIEW

1.1 THE MODEL 2228 COMMUNICATIONS CONTROLLER

Physically the Model 2228 Communications Controller is a double-card controller which plugs into any I/O slot in a System 2200 Central Processing Unit (CPU). To operate the controller and any of the Wang-generated terminal emulator programs associated with the controller, the CPU must include the $GIO and MAT COPY (and in some cases the ON ERROR) statements in its BASIC language instruction set. The statements are standard in several CPU models and available in options for other models (see Appendix A).

A 25-pin EIA (Electronic Industries Association) RS-232-C, CCITT V.24 compatible connector mounted on the controller and a 12-foot (3.6 m) Wang-supplied cable facilitate hookup of a modem, i.e., a modulator/demodulator. A modem is needed to convert (modulate) the data signals from a terminal into a range of frequencies suitable for transmission over telephone lines, and demodulate data signals being received via telephone lines; hence, some modem considerations are presented in Section 1.3.

The Model 2228 controller has its own microprocessor, a read-only memory, and a random access memory. Since space is reserved in the random access memory for multicharacter input and output buffers, data transmission/reception operations performed by the controller with respect to a modem can overlap data input/output operations performed by the CPU with respect to the peripherals used for a communications application. The overlap feature increases data throughput capabilities during online operations.

Wang-generated microcode, included in a terminal emulator package supplied for each Model 2228 controller, is loaded into the controller's random access memory from the CPU prior to going online for data transmission and reception. The microcode implements many controller operations associated with emulation of a particular communications protocol, such as the binary synchronous communications (BSC) protocol used by an IBM 2780, 3780 or 3741 terminal.

With the Model 2228 controller, a suitable modem, and one of the Wang-generated terminal emulator programs, a Wang computer system can transmit and receive data over telephone lines. Thus, the system can be linked readily to another comparably-equipped Wang system or to any host computer which customarily communicates with terminals having the characteristics featured in the terminal emulator program being used. Furthermore, no changes in existing software at the host site are necessary.

Cost effective transmission of batched data is provided by a Wang system equipped with a Model 2228 Communications Controller since the CPU with its

comprehensive BASIC language can be used offline to preprocess data and store the results on the medium corresponding to the terminal input device, e.g., a card reader, diskette, or disk. Then, when convenient, the stored data is transmitted to another system. Also, data received online is stored on the medium corresponding to the terminal output device, e.g., a printer, diskette, or disk. Then, utilizing the standalone computer capabilities of the CPU, the received data can be postprocessed offline.

The binary synchronous communications protocol implemented by the Model 2228 controller, when operating with a Wang-supplied 2780, 3780 or 3741 emulator program, is designed specifically for efficient transmission of large volumes of data at high speed; data integrity is maximized, and communications overhead is minimized.

1.2 INSTALLATION

Whether a Model 2228 Communications Controller is being added to an already installed Wang system or is part of a system yet to be set up, installation of the controller is the responsibility of a Wang Service Representative who should be notified when the controller arrives.

After the controller is inspected, diagnostically checked, and installed in the CPU, one end of the cable supplied with the controller is plugged into the connector on the controller. Normally, the other end of the cable is plugged into a modem.

Installation of a modem is not the responsibility of a Wang Service Representative.

1.3 MODEM CONSIDERATIONS

With any Wang binary synchronous communications package, the Model 2228 controller supports synchronous transmission and reception at line speeds up to 4800 bits per second, depending upon the modem used with the controller. The controller requires that the modem provide the transmitter and receiver clock signals which must accompany the data signals to ensure synchronization.

A modem may be rented from the telephone company serving the locality where a Wang system is installed or may be purchased from any one of several modem vendors. In either case, installation of a modem must be scheduled with the local telephone company since modems purchased from a vendor must be connected to the telephone network via telephone company installed data access arrangements (DAA). DAA's consist of a telephone handset and modem interface rented from the telephone company.

Normally, a modem or DAA is wired permanently to a wall; therefore, it is important to know the planned location of a Wang computer system before a telephone company representative arrives to install equipment. Keep in mind that subsequent relocation of the Wang system any great distance may necessitate having the telephone company relocate the modem or DAA.

Compatible Modems

With the Model 2228 controller and one of the Wang-generated binary synchronous communications packages, the following dial-up modems (or their equivalents) can be used. See Table 1-1 for options to be selected for each modem.

Bell 201A A 2000 baud (bps) synchronous modem which supplies the clock signal to the controller. The 201A type modem is an older generation modem recommended only for applications where the host system exclusively supports 2000 bps (bits per second) service.

Bell 201C A 2400 baud (bps) synchronous modem, similar in operation to the 201A but newer, smaller and lighter. For many applications, the 201C modem or its equivalent should be the best compromise between price and performance.

Bell 208B A 4800 baud (bps) synchronous modem, similar in operation to the 201A and 201C types. The 208B modem or its equivalent provides the maximum transmission throughput capability of all the Bell modems suited to the Model 2228 controller and Wang's BSC packages; however, rental rates are 30 to 40 percent higher than the rates for 201 type modems.

Bell 202C or 202S Asynchronous modems compatible with a special option provided in Wang's BSC packages for 1200 baud (bps) transmission. Use of either modem is not a usual choice, but can occur in circumstances where synchronous modems are not available.

> NOTE:
>
> Modems used at both ends of a point-to-point dial-up communications link must be of similar type. For example, if a Bell 201C is used at one end, another Bell 201C type modem or equivalent must be used at the other end (not a 201A, 208B, 202C or 202S).

Unless compatibility or high throughput considerations dictate otherwise, a 201C type modem is recommended for communications via telephone lines.

Table 1-1. Modem Options

Bell Data Set (or equivalent)	Options to be Included or Excluded
201A or 201C	EIA Interface Transmitter Internally Timed With Alternate Voice Without 801 Automatic Calling Unit Without New Sync EIA Ring Indicator Automatic Answer (Selective) Carrier Controlled by Request to Send Half-duplex (2-wire)
208B	all the options above, plus: CC on when AL Pressed (Note: CC = Data set ready.)
202C or 202S (Not normally used)	Half-duplex No Reverse Channel Automatic Answer (Selective) EIA Voltage Interface RS-232-C

1.4 TERMINAL EMULATOR PACKAGES

Currently, three Wang-generated terminal emulator packages are available for the Model 2228 controller. One package emulates the binary synchronous communications protocol and data message features of an IBM 2780 terminal. A second package emulates the BSC protocol and data message features of an IBM 3780 terminal. A third package emulates the BSC protocol and data message features of an IBM 3741 terminal.

One copy of one terminal emulator package with a user's manual is provided for each Model 2228 Communications Controller ordered for a Wang system. Additional terminal emulator packages can be ordered, if desired.

An outstanding feature of the terminal emulator packages is a SYSGEN (System Generation) program which permits the user, in response to a set of questions appearing on the CRT, to designate the I/O peripherals and other information such as the type of modem to be used for data transmission/reception. Then, the SYSGEN program automatically generates on another diskette (or a disk) a customized communications program having the following modules:

- an initialization/loader module called TCSTART,
- a microcode data module related to the BSC line discipline,
- a CPU/controller interface module related to the specified I/O configuration, and
- a code translation module.

The generated communications program includes such features as operator prompts, special function key control of transmission and reception, error messages, and modem status information, all provided with a primary objective in mind -- operational simplicity requiring minimal training of non-programming personnel responsible for data transmission/reception.

With SYSGEN residing on a master diskette from Wang Laboratories, no programming effort is required when a facility wishes to change the designated I/O peripherals or other available options for a communications application. By running SYSGEN again, another program can be generated for a different set of options.

The SYSGEN program, its options, and operating instructions are described in detail in Chapter 2. Also, questions requiring answers when SYSGEN is run are summarized in a checklist. If reproduced, the checklist provides an easy-to-use form for recording the options selected during generation of a communications program.

General operating instructions, including establishing a connection via a modem, are given in Chapter 3 for communications programs generated from SYSGEN. Also, data format and peripheral considerations are included in the chapter.

1.5 SOME BACKGROUND INFORMATION

Some background information related to the 2780 emulation package described in this manual is included here for readers who may be interested. The information is not needed for successful operation of the SYSGEN program or any communications program generated from SYSGEN; hence, this section can be ignored by any reader seeking operational instructions only.

The 2780 binary synchronous communications (BSC) line discipline groups records into blocks, each of which may contain several records (called multirecord blocking) or only one record (called single record blocking). Most host computers support multirecord blocking because it has inherently greater throughput capability; however, some host systems may require single-record blocking. For this reason, Wang's SYSGEN program allows the user to choose which type of record blocking is to be implemented by the Wang system.

To govern data transmission, the 2780 BSC discipline employs a standard set of communications control characters. Such control characters are automatically generated and decoded by the Model 2228 controller as necessary.

To ensure error free transmission of message and data blocks, a cyclic redundancy check (CRC) character is calculated with respect to the data in each block and appended to each transmitted block. In accordance with the BSC line discipline, the receiving system recalculates a CRC character based on the data in the received block and compares its calculated value with the CRC character received from the transmitting system. If the compared CRC characters disagree, the receiving system issues a request for retransmission of the block. The CRC error checking procedure is very reliable and essentially guarantees that received data has no errors introduced by transmission difficulties.

Many computer systems consider data records received from a 2780 type terminal to be in error if not exactly 80 bytes in length -- since such terminals usually transmit data from cards, and card image records are normally 80 bytes long. To avoid problems associated with such a constraint, Wang's 2780 emulation programs automatically shorten records longer than 80 bytes to 80 bytes and pad records shorter than 80 bytes with blanks to ensure compatibility with all computer systems using the 2780 discipline. (An exception to the 80-byte record length is employed in the SYSGEN option for communications between two Wang systems.)

Generally speaking, there are two types of data-link configurations associated with 2780-type terminals -- multipoint and point-to-point configurations. Each type of configuration uses a slightly different version of the 2780 line discipline. The multipoint discipline is used when several terminals are simultaneously connected to the same dedicated, leased, or privately owned communications line. The point-to-point discipline is used when only one terminal is connected to each line going into a host computer (whether the lines are dedicated or part of the dial network). Currently, Wang's 2780 emulation package supports only the point-to-point BSC line discipline. Normally, Wang systems are used for online communications only part time because of their extensive computer capabilities for many purposes, including preprocessing of data to be communicated and postprocessing of data received from remote sources. For such applications, point-to-point dial-up networks are usually more economical than leased networks.

During the actual operation of a Wang 2780 emulation program, the user can transmit data in EBCDIC (Extended Binary Coded Decimal Interchange Code) form or in "transparent" form merely by depressing the special function key associated with the desired choice. The 2780 emulation package assumes the normal transmission code set is EBCDIC and automatically translates data from the ASCII code set native to Wang systems into EBCDIC prior to transmission unless the transparent mode is initiated by the operator. No code translation is performed on transparent data.

CHAPTER 2
GENERATING A COMMUNICATIONS PROGRAM

2.1 THE 2780 EMULATION UTILITIES PACKAGE

Wang's IBM 2780 Emulation Utilities Package for the Model 2228 Communications Controller provides the capability to generate many turnkey communications programs, each of which is suited to a particular choice of I/O devices for data transmission/reception and other options described in Section 2.3. The package is available on three media, as described in the Preface.

> NOTE:
>
> The disk image on cassette 2780 emulation package must be copied from cassette to disk as explained in Appendix D. If the package obtained from Wang Laboratories already resides on disk (i.e., a flexible disk or diskette), ignore Appendix D.

2.2 SYSGEN: WHAT, WHY, AND WHEN TO USE

What Is SYSGEN?

SYSGEN, an abbreviation of the words "system generation", is a convenient name given to a program designed to interrogate the user's preferences with respect to a set of options and then automatically construct a communications program fulfilling the user's specifications.

The SYSGEN program, together with a set of I/O modules and microcode files, is supplied in the 2780 emulation package.

Why Is SYSGEN Provided?

SYSGEN is Wang Laboratories' answer to an ambitious objective - maximizing the communications capabilities of a disk-based Wang system while minimizing the complexity of a set of turnkey programs for a variety of communications applications.

Keep in mind that a particular facility may wish to transmit data currently stored on disk and receive data for immediate output to a printer. A disk-send/printer-receive combination of peripherals may be the only I/O configuration to be used when communicating with another site. On the other hand, another facility (or the same facility communicating with a different site) may wish to transmit card input and receive data for immediate storage on disk.

However, an operational program designed to control data input optionally from either a disk or a card reader for transmission, and control data reception for output optionally to either a printer or a disk is more complex and requires more memory to provide four possible I/O combinations than a program tailored to the specific I/O needs. Furthermore, the number of I/O combinations escalates when the number of optional input devices and the number of optional output devices increase.

Tailoring a communications program to specific I/O peripherals not only reduces memory requirements but also reduces the operational complexity of the resulting program. Operational simplicity is an important goal since many people, including non-programming and programming personnel, may be involved in data transmission and reception at some facilities.

When Should SYSGEN Be Used?

The SYSGEN program should be used initially to generate one communications program which is suited to a desired I/O configuration, the type of modem to be used, and other options (see Section 2.3). Thereafter, SYSGEN should be run only when the need arises for another communications program representing different options.

SYSGEN operating instructions are given in Section 2.4.

2.3 SYSGEN OPTIONS

The SYSGEN options are summarized, for convenience, in a checklist which appears twice in this manual. In this section the checklist serves as a preview of the set of questions (A through I) which appear on the CRT sequentially when the SYSGEN 2780 Emulator program is run. Each question is discussed individually in Table 2-1. The information should prove helpful to anyone using the SYSGEN program for the first time.

The checklist is repeated in Appendix C to serve as a reproducible form. A copy of the checklist, properly checked and filed with each generated program, provides a convenient summary of the selected options.

Checklist

SYSGEN 2780 EMULATOR

A. THE SYSGEN PROGRAM WAS JUST LOADED FROM

1 DISK UNIT 310 _____
2 DISK UNIT B10 _____
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

B. THE GENERATED SYSTEM WILL BE CREATED ONTO

1 DISK UNIT 310 _____
2 DISK UNIT B10 _____
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

(A hard disk or diskette drive can be used.)

C. GENERATED SYSTEM WILL BE LOADED FROM

1 DISK UNIT 310 _____
2 DISK UNIT B10 _____
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

D. DATA WILL BE TRANSMITTED FROM

1 DISK _____
2 CARD READER _____
3 DUMMY FOR TESTING _____

(DISK = any hard disk or diskette drive; any reply allows keyboard input.)

E. RECEIVED DATA WILL BE OUTPUT TO

1 DISK _____
2 LINE PRINTER _____
3 DISK & PRINTER _____
4 DUMMY FOR TESTING _____

(DISK = any hard disk or diskette drive.)
(Reply 3 emulates punch/print reception.)

F. WHEN OPENING AND CLOSING DISK FILES, SYSTEM SHOULD USE

1 METHOD 1 (ON ERROR) _____
2. METHOD 2 (SRCH CATLG) _____

(Method 2 is recommended. See Table 2-1.)

G. TYPE OF MODEM TO BE USED IS

1 201A, 201C, or 208B _____
2 202C or 202S _____

H. DATA WILL BE TRANSMITTED BETWEEN THIS SYSTEM AND

1 ANY OTHER COMPUTER _____
2 A WANG 2200 SYSTEM _____

(If the answer to E is 2 or 3, use reply 1 only. See Table 2-1.)

I. WHEN TRANSMITTING, CONTROLLER WILL BLOCK DATA INTO

1 MULTI-RECORD BLOCKS _____
2 SINGLE RECORD BLOCKS _____

(Question I is omitted if the answer to H is 2.)

Table 2-1. Answers to SYSGEN Questions

Question	Reply
A	Give the number corresponding to the address of the drive on which the master disk/diskette is currently mounted. (The address is needed when the SYSGEN program begins to copy and merge particular I/O modules and microcode files to create a communications program fulfilling specified options.) Note: Use of a duplicate master is recommended; the original master should be stored to provide a backup capability.
B	Give the number corresponding to the address of the drive currently containing the indexed disk/diskette on which the generated system is to be stored. (The A and B addresses normally differ since at most one generated system can reside on a particular platter.)
C	Questions C and B are independent; therefore, their answers may be the same or different. Keep in mind that the answer to C imposes a restriction - the generated program must be loaded only from the address specified here.
D	The answer specifies the type of input device from which stored data will be retrieved prior to transmission. The designated device determines which input module is to be copied from the master diskette. (If reply "3" is made, the input module provides a fixed message to be retrieved from memory for test purposes only.)
E	The answer specifies the type of output device to be used for storage of received data. The designated device determines which output module is to be copied from the master disk/diskette. (If reply "4" is made, the output module utilizes a single line of the CRT to display data received for test purposes only. If reply "3" is made, the output module emulates punch/print reception; any data preceded by a punch control character is stored on disk, and any other data is printed.)
F	The answer determines which disk file opening and closing procedure is to be implemented by the generated program if the designated input or output device is a disk. (The answer is ignored if non-disk I/O devices are designated.) With either disk method*, up to 99 files can be received based upon one six-byte, operator-supplied file identifier (the system automatically adds two bytes to identify each sequential file, e.g., 01, 02, ..., 99). The methods differ as follows: a) Method 1 uses the statement ON ERROR to capture and flag errors when sending or receiving files; the operator must restart a data transfer sequence if an error occurs. When receiving files, each file is opened with the same amount of space (using the operator-supplied value); unused space is not freed. b) Method 2 searches the catalog for the validity of operator-supplied file names when sending or receiving files; new names are requested automatically if needed. When receiving files, each file is opened with the allotted space temporarily equal to all available space; then unused space is freed when a file is closed. *Method 2 is recommended unless there is a need to limit the memory requirement to 8K.
G	Give the number corresponding to the type of modem to be used for online communications.
H	Give the number corresponding to the type of remote computer to which data will be sent. Reply 2 is recommended for communications between two Wang systems (unless a printer is used for output); with reply 2, program and data files are transmitted in transparent mode with each disk sector automatically divided into two 128-byte records.
I	Generally speaking, the reply to I should be "1" since multi-record data blocking by the controller (up to seven records or 400 bytes per block) is more efficient than single record blocking. However, for those applications where the remote computer facility requires single record blocks, reply 2 provides the option for single record blocking.

2.4 SYSGEN OPERATING INSTRUCTIONS

To generate a communications program, proceed as follows:

1. Mount the master disk/diskette in any unit having an address 310, B10, 320 or B20.

2. Mount an indexed disk/diskette in any drive not used in Step 1. (If using a new disk/diskette, be sure to format and scratch the platter.)

3. Depending upon the drive used in Step 1, enter a command of the form:

   LOAD DC {F|R} [/xyy,] "SYSGEN"

   and key RETURN(EXEC).

4. Enter the command RUN and key RETURN (EXEC).

5. Respond to each question which appears on the CRT. While doing so, use a copy of the checklist to check each reply, thereby ensuring accurate identification of the communications program after its generation. (See Table 2-1 in Section 2.3 for information.)

6. When the SYSGEN program automatically generates a communications program fulfilling the options selected in Step 5, several displays appear on the CRT; each display indicates the name of a file currently being opened, copied, merged or closed. No operator intervention or action is required during this phase.

7. When the following display appears:

   ```
   SYSGEN SUCCESSFULLY COMPLETED.
   STOP
   :_
   ```

   remove and store the master disk/diskette until a new communications program with different options is needed.

(continued on next page)

NOTES:

1. If a non-indexed or no disk/diskette is used in Step 2, a line of text followed by error code 64 appears. To recover, correct the porblem and return to Step 4.

2. If the platter used in Step 2 already contains a previously generated program, the following display appears:

   ```
   FILE TCSTART ALREADY EXISTS ON THE SYSGEN OUTPUT DISK
   STOP   SYSGEN ABNORMALLY TERMINATED
   :_
   ```

   To recover, correct the problem and return to Step 4.

8. Enter the command CLEAR and key RETURN (EXEC).

9. The disk/diskette used in Step 2 now contains the following files:

TCSTART	--	the initialization/loader module.
BSC-000A	--	the microcode data file.
BSC-000B	--	the CPU/controller interface module plus selected I/O modules.
BSC-000C	--	the code translation tables.

   The existence of the files can be checked, if desired, by listing the contents of the catalog index.

NOTE:

The SYSGEN program always produces files having the names shown in Step 9; therefore, only one communications program can be stored on the particular disk/diskette used in Step 2. However, any number of programs can be generated by storing each program on a separate platter.

CHAPTER 3

OPERATING A COMMUNICATIONS PROGRAM

3.1 PERIPHERAL CONSIDERATIONS

Before going online to transmit and/or receive data via a Wang system equipped with a Model 2228 controller, an operator should know the following:

- Is data to be transmitted? If so, which peripheral is to serve as the input device?
- Is data to be received? If so, which peripheral is to serve as the output device?
- Is a 2780 emulation program for such an I/O configuration already available? If so, where is the program stored?

Section 2.3 lists the I/O configurations and other options available in Wang's 2780 Emulation Utilities package. Once a 2780 emulation program is generated using SYSGEN, the resulting program can be used repeatedly. The program provides the capability to retrieve data from the designated input device for transmission to another computer or terminal, and receive data from another computer or terminal for immediate storage or printout via the designated output device. Furthermore, the program supplies and automatically loads the microcode which enables the controller to monitor modem signals, to format data in multi-record or single-record blocks, to insert all necessary data-link control characters prior to transmission, and to recognize and respond to control characters when receiving data from the remote end of the line.

The CPU requirements for each I/O configuration are summarized in Appendix A.

3.2 DATA CONSIDERATIONS

Wang Laboratories has defined a "telecommunications (TC) format" for disk data files. The TC format can be bypassed only if using a communications program generated for data transmission between two Wang 2200 systems (i.e., only if the answer to SYSGEN question H was "2" when the program was generated). Otherwise, data to be transmitted from disk must be stored in the TC format prior to going online for transmission. Furthermore, data received for output to disk is automatically stored in TC formatted files (unless the answer to question H was "2").

The TC format is described in detail in Appendix B. Some background information is given in this section.

An IBM 2780 Data Transmission Terminal is designed for large volume transmission of card data using a card reader for input and a printer and/or a card punch for output; therefore, in 2780 terminology, a record is the data in a single card or a single line of print. Accordingly, when any system emulates the 2780 line discipline acceptable to many large scale computer centers for remote job entry of batched data or other applications, an 80-byte maximum record length (corresponding to an 80 column card) is the transmission standard.

A Wang system with a Model 2228 controller and a 2780 Emulation Utilities Package is designed for large volume data transmission using a disk, diskette, or card reader for input, and using a disk, diskette, printer, or disk and printer combination for output. With input via a card reader, the system recognizes each card as an individual unit; therefore, limiting the maximum record length to 80-bytes is consistent with the physical characteristics of card input and the 2780 line discipline. With input via a disk (whether a hard disk or diskette drive is used), the system recognizes each sector on the disk as an individual unit. A sector can hold 256 bytes of information, not all of which can be filled with the user's data since several bytes are needed for format information within the sector.

As explained in the disk manual accompanying each disk in a Wang system, data to be stored in a disk file should be organized with due care for packing a maximum amount of data in a minimum number of sectors. Furthermore, to avoid problems when retrieving data from a disk file, the argument list for any disk statement used to retrieve data should correspond to the argument list used in the statement which stored the data on the disk. Therefore, Wang Laboratories has developed a convenient technique, called the TC format, by which variable length records up to 192 bytes maximum can be stored on disk for subsequent transmission.

Wang's TC format for disk data files provides sufficient generality to accommodate the many different types of records normally stored on disk -- yet the format avoids the problems which arise if the argument list used to retrieve data does not match the argument list used to store data. The TC format achieves generality by requiring the packing of variable length records into a one-dimensional alphanumeric array having four elements, each 62 bytes long. Within the 248 contiguous bytes of the array, prescribed control information must be supplied (see Appendix B). The array is saved into a single sector on disk using a DATASAVE DC or DATASAVE DA statement. The control information within the array is utilized by the turnkey communications program when retrieving data from a TC formatted file for transmission using the 2780 line discipline.

Even though the TC format allows variable length records up to 192 bytes maximum to be stored on disk for subsequent transmission, the communications program automatically truncates or pads data, as necessary, to achieve the standard 80-byte record length required for data transmission to a non-Wang computer which customarily accepts the 2780 communications protocol.

On the other hand, in the special cases where a communications program is being used to transmit/receive disk files between two Wang systems, the user's applications program does not need to store data on disk in the TC format; furthermore, received disk files are not output in TC format. In such cases, the disk send/receive communications program (generated with reply "2" for SYSGEN question H) provides the capability to transmit and receive both program and data files -- if the files conform to the standard Wang formats for program and data files. The communications program transmits the disk files using 128-byte records since conformity to the 80-byte maximum record length is not required when the other terminal is another Wang system using a 2780 emulation program generated for communications between two Wang systems.

It is the responsibility of the user's applications program to store data on disk in Wang's TC format. A standalone utility program called Data Entry 1, originated by Wang Laboratories, is available as part of the TC Support Utilities 1 package to allow the user to create TC formatted disk files or to edit, delete, rearrange, create, and list records in an existent TC formatted disk file.

Also, it is the responsibility of the user's applications program to read and process received data files which have been output to disk in TC format by a 2780 emulation program.

> NOTE:
>
> Before going online to transmit data, an operator should know where the data is currently stored. Furthermore, the data should be formatted in accordance with the specifications in Appendix B if data is being trnasmitted from disk to any other computer, except another Wang system operating with a special communications program.

3.3 LOADING A COMMUNICATIONS PROGRAM

Each 2780 emulation program, generated using SYSGEN, includes an initialization/loader module named TCSTART. Therefore, the following procedure is used to load a communications program:

1. Mount the disk/diskette on the drive corresponding to the "loading address" (i.e., the address specified in the reply to SYSGEN question C when the program was generated).

2. Using the appropriate F or R parameter and the address (if not a default address), enter a command of the form:

   LOAD DC {F / R} [xyy,] "TCSTART"

   and key RETURN(EXEC)

3. Then, enter the command

RUN

and key RETURN(EXEC).

Now, while the system loads the microcode in the controller, loads the CPU/controller interface module in the CPU, and loads the code translation tables, the following display appears on the CRT.

```
**********************
*                    *
*   WANG SYSTEM 2200 *
*  IBM 2780 EMULATOR *
*    RELEASE x.x     *
*   LOADING SYSTEM   *
*                    *
**********************
```

The actual release identification number replaces x.x.

Shortly thereafter, the system enters the CONTROL mode discussed in Section 3.4, and the first display conforming to the screen layout shown in Figure 3-1 appears. The displays, prompts, error messages, and general instructions associated with operation of a communications program are discussed in the sections which follow.

During the loading operation, several types of errors are possible. For example, an ERR 64 can occur when Step 2 is executed if the disk is incorrectly mounted. If so, check the addressed drive to be sure the program disk is there and correctly mounted. When Step 3 is executed, one of the following error messages may appear below the asterisk-bordered rectangle:

STOP ERROR ON WRITE
STOP ERROR ON READ
STOP ERROR ON COMPARE

If such an error occurs, clear the system and repeat the loading procedure. After checking the equipment and repeating the procedure, call the Wang Service Representative if loading errors persist.

3.4 MODES OF OPERATION

Each 2780 emulation program provides two-way communications utilizing five modes of operation: CONTROL, BID, SEND, RECEIVE, and ATTENTION, as described in Table 3-1. A particular mode may be entered many times or not at all, depending upon operator input and the number of messages originating from the remote end of the line.

At any given time, only one mode of operation is in effect. For example, after the TCSTART module is loaded into the CPU and the command RUN followed by RETURN(EXEC) is keyed, the system loads the microcode in the controller, loads the CPU/controller interface module in the CPU, loads the code translation tables, and then enters the CONTROL mode first. The display

shown in Figure 3-1 appears on the CRT, with the word CONTROL in the lower right corner under the mode label as follows:

```
---MODE---
CONTROL
```

Once in the CONTROL mode, the system waits indefinitely if no action occurs; however, when action occurs and the system enters another mode, the name of the current mode is displayed under the mode label in the lower right corner. Keep in mind that transmission (sending data or messages) is initiated by the operator, and reception is initiated by the remote end of the line -- after a communications link has been established.

During each mode of operation, one or more currently active keyboard controls are displayed on the second line of the CRT. For example, during the CONTROL mode the first two lines of the CRT appear as follows:

```
   ACTIVE KEYBOARD CONTROLS
'0=CONTROL   '1=ATTN   '2=SEND   '3=SEND TRSP   C/R=KYBD
```

The operator should be familiar with the action associated with each active control key, as described in Table 3-2.

Tables 3-1 and 3-2 should be studied carefully and kept readily available by anyone operating a communications program -- until thoroughly familiar with a communications application. The active keyboard controls, as well as the action associated with each control, are device-independent for four of the five modes of operation (CONTROL, BID, SEND, AND RECEIVE); hence, Table 3-2 applies to any communications program obtained by running the SYSGEN program, regardless of the particular I/O configuration specified for the program (see Section 2.3).

On the other hand, the active keyboard controls for the ATTENTION mode are device-dependent, as shown in Table 3-3. Keep in mind that the system enters the ATTENTION mode from the CONTROL mode only if the operator presses special function key 1. However, there is no need to enter the ATTENTION mode until a prompt appears on the CRT indicating that a receive-device is not ready, or until the operator desires to adjust the paper in a printer via a special function key (if the printer is the designated output device), or desires to erase a disk file which is not automatically closed by the system.

CAUTION:

1. Do not touch RESET at any time during operation of a communications program. If a RESET signal occurs during CPU to controller action, the controller may "lock" thereby requiring the operator to clear and reload the program to recover.

2. Do not touch HALT/STEP followed by special function key 0 during the SEND mode; a "SYSTEM ERROR" occurs, requiring master initialization or clearing of the system and reloading of the program. If HALT/STEP is inadvertently keyed, recover by keying CONTINUE then RETURN(EXEC).

Table 3-1. Modes of Operation

Mode	Description
CONTROL	The system automatically enters the CONTROL mode first. While in this mode, the system monitors the communications line and the keyboard -- awaiting action from either the operator or the remote end of the line. When action occurs, the system branches to an appropriate location in the program and may enter another mode of operation. If no action occurs, the system remains in the CONTROL mode indefinitely.
BID	If the operator initiates data transmission by pressing S.F.'2 (SEND) or S.F.'3 (SEND TRSP) during the CONTROL mode, the system prompts the operator to supply input-device-related information shown in Table 3-6, and then enters the BID mode. In this mode, the system bids for control of the line by requesting permission to transmit a message, and continues to do so until one of the following occurs: a) permission is granted by the remote end, b) 16 requests fail, or c) the operator aborts the mode via S.F.'0 (ABORT). If permission to transmit is granted, the system enters the SEND mode; otherwise, the system returns to the CONTROL mode.
SEND	After entering this mode following successful completion of the BID mode, the system transmits data (normally or transparently depending upon whether S.F.'2 or '3 initiated the action) and continues to do so until one of the following occurs: a) all data is sent, b) an operator at either end of the line aborts the transmission, or c) transmission difficulties arise,such as the line being disconnected. In any event, the system returns to the CONTROL mode.
RECEIVE	Only the remote end of the line can activate the RECEIVE mode. In this mode, the system collects data being sent from the remote end and outputs the data to the designated output device, continuing to do so until one of the following occurs: a) an end-of-transmission code is received, b) an operator at either end of the line aborts the transmission, or c) transmission difficulties arise, such as the line being disconnected. In any event, the system returns to the CONTROL mode. (Note: If outputting to a printer which has insufficient paper, the system may remain in the RECEIVE mode.)
ATTENTION	If the operator presses S.F.'1 (ATTN) during the CONTROL mode, the system enters the ATTENTION mode and displays the device-related active controls shown in Table 3-3. Normally, an operator activates this mode only for one of the following reasons: a) to form feed, vertical tab, or line feed a printer before additional output is received, b) to supply disk-related information, if a RECEIVE DISK FILE NOT OPENED prompt appears, or c) to erase a file, if the last file opened by the system is not automatically closed. After the operator supplies information in response to a set of prompts, or presses special function key 0, the system returns to the CONTROL mode.

Table 3-2. Available Operator Controls During Each Mode of Operation

Mode	Active Controls	Action
CONTROL	S.F.'0=CONTROL	Directs the system to remove any status and error messages remaining from the last SEND and RECEIVE modes. (Note: the number of blocks sent is not altered until the next SEND mode occurs, and the number of blocks received is not altered until the next RECEIVE mode occurs.)
	S.F.'1=ATTN	Directs the system to enter the ATTENTION mode, thereby allowing the operator to ready the output device, or supply information via the new set of active controls shown in Table 3-3. (Note: The available controls during the ATTENTION mode are device-dependent and are determined by the designated output device for the communications program being used.)
	S.F.'2=SEND	Directs the system to send data in EBCDIC character form -- after first requesting operator-supplied, input-device-related information shown in Table 3-6, and successfully bidding for the line.
	S.F.'3=SEND TRSP	Directs the system to send data transparently, i.e., to send data in binary form, using special control characters defined by the BSC protocol -- otherwise, same as S.F.'2.
	C/R=KYBD	The RETURN(EXEC) key directs the system to accept a single record to be entered via the keyboard. (This option is useful for sending a sign-on message to the host computer or sending status requests such as $DN to a HASP operating system.) As a visual aid, a 63-character position-indicator is displayed, and each entered character appears below the indicator; the backspace and line erase keys are active for editing the keyboard input. The RETURN(EXEC) key must be used again to signify the end-of-message and direct the system to begin transmission; no message is sent if the line is blank.
BID	S.F.'0=ABORT	Directs the system to terminate the BID cycle and return to the CONTROL mode. No data or message is sent.
SEND	S.F.'0=ABORT	Directs the system to terminate the transmission. However, before returning to the CONTROL mode, the system sends the last data block currently in memory and then signals the remote end that transmission is aborted. (Note: Abort procedures vary from host to host -- one host may clear the transmission; another may attempt to execute a partial transmission. In the latter case, a "cancel job request", entered as a single record via the keyboard, may be required in addition to the abort signal.)
RECEIVE	S.F.'0=ABORT	Directs the system to terminate reception. However before returning to the CONTROL mode, the system signals the remote end that an abort request has been made, and then follows the abort procedure used by the remote end.
ATTENTION	See Table 3-3.	(Note: During the ATTENTION mode, the available operator controls are device-dependent, depending upon the designated output device.)

Table 3-3. Device-dependent Active Controls During the ATTENTION Mode

Output Device	Active Controls	Action
Disk (Method 2, Srch Catlg)	S.F.'0=CONTROL	Directs the system to return to the CONTROL mode.
	S.F.'1=OPEN FILE	Prompts the operator successively as follows: ENTER RECEIVE DEVICE ADDRESS 1=310 2=B10 3=320 4=B20 ENTER FILE IDENTIFICATION NOT TO EXCEED 6 CHARACTERS Upon receiving a response to the second prompt, the following message appears: SEARCHING CATALOGUE If the operator-supplied identifier is already in the catalog, the system displays an error message xxxxxx CATALOGED RE-ENTER, where xxxxxx is replaced by the file identifier code; otherwise, the system opens the first file with the operator-supplied identifier. The allotted space is equal to all the currently available space on the disk. Then, the message RECEIVE FILE xxxxxx01 OPENED appears, and the system returns to the CONTROL mode. (Note: Prior to displaying the first prompt, the system erases any currently open file on the disk.)
	S.F.'2=ERASE FILE	Allows the operator to erase one of the following files: a) the last file opened automatically by the system, thereby freeing unused disk space before terminating the communications program, or b) any file in the catalog index (space is not freed unless the file is the last file with respect to the sectors being used currently). The following message appears ERASE FILE -------- OR ? The message contains the name of the last file opened by the system during current operation of the program. After the operator supplies a different file name or keys RETURN(EXEC) to erase the file named by the system, the following messages appear: SEARCHING FOR FILE FILE ------ ERASED Then, the system returns to the CONTROL mode.
Disk (Method 1, On Error)	S.F.'?=CONTROL	Directs the system to return to the CONTROL mode.
	(The first prompt appears immediately.)	ENTER RECEIVE DEVICE ADDRESS 1=310 2=B10 3=320 4=B20 Upon receiving a valid response, the system prompts the operator successively as follows: ENTER FILE IDENTIFICATION NOT TO EXCEED 6 CHARACTERS ENTER NUMBER OF SECTORS TO OPEN RECEIVE FILES Upon receiving a response to the above prompt, the system attempts to open the first file. If the file name already exists, the message STOP NAME ALREADY CATALOGED appears (the operator must key S.F.'0 to resume); otherwise, the system opens the first file and displays the message RECEIVE FILE xxxxxx01 OPENED Then the system returns to the CONTROL mode.
Printer	S.F.'0=CONTROL	Directs the system to return to the CONTROL mode.
	S.F.'13=FORM FEED	Executes form feed operation and returns to the CONTROL mode.
	S.F.'14=VERT TAB	Executes vertical tab operation and returns to the CONTROL mode.
	S.F.'15=LINE FEED	Executes line feed operation and returns to the CONTROL mode.
Disk & Printer	Note: If the designated output device for the operating communications program is a disk and printer, the system displays any not ready status messages related to the disk first. Any printer not ready status message, if applicable, appears after operator-supplied information is furnished for the disk. The active controls displayed during the ATTENTION mode depend upon which disk method is in effect. The controls are the same as shown for the particular methods 1 and 2 in the table.	

3.5 INITIAL OPERATOR ACTION

Since data reception is controlled by the remote end of the line, the designated output device should be ready when the remote end begins to transmit data. For this reason, each 2780 emulation program automatically checks the device ready status of its designated output device. If the device is not ready, a message is displayed when the system first enters the CONTROL mode.

Generally speaking, unless an operator is certain that no data is to be received, the operator should ready the output device before establishing a connection with a host system or a terminal. In particular, if the output device is a printer which has been turned on and manually selected, no device ready status message appears; if not ready, the message PRINTER NOT READY appears. If the output device is a storage device (a disk), the message RECEIVE DISK FILE NOT OPENED appears. Normally, the operator should press S.F.'1 to activate the ATTENTION mode and then supply the device-related information described in Table 3-3. After the required information is furnished, the system automatically returns to the CONTROL mode.

Now, in accordance with prearranged and special procedures related to a particular application, the operator may establish a connection with a host computer or another terminal, or the operator may await a telephone call initiated by someone else. In either case, the operator should be familiar with the information in the next section.

3.6 DISPLAYS, PROMPTS, STATUS AND ERROR MESSAGES

Prompts, as well as status and error messages, appear on the CRT during operation of any 2780 emulation program generated from Wang's utility package. The particular locations where specific types of information appear are shown schematically in Figure 3-1, using line numbers (1 through 13) to simplify the discussion which follows.

Some information is device-independent; other information is device-dependent. Some information is common to all modes of operation; other information is related only to specific modes of operation. For example, as discussed previously in Section 3.4, the active controls which appear on line 2 of the display are related to the current mode of operation as summarized in Tables 3-2 and 3-3. Five controls are active during the CONTROL mode, but only one is active during the BID, SEND, and RECEIVE modes. On the other hand, the number of active controls during the ATTENTION mode depends upon the designated output device. However, by observing the second line on the CRT, the operator knows immediately just which controls are currently active.

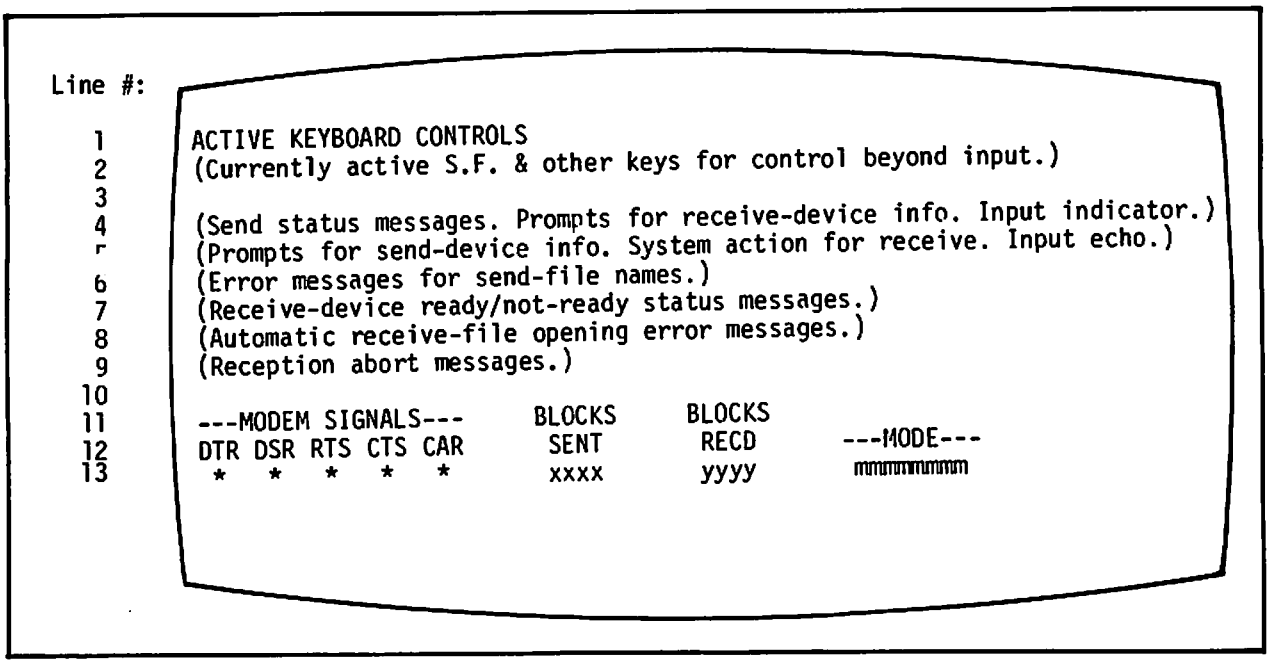


Figure 3-1. Screen Layout During Emulation Program Operation

During all modes of operation, the labels shown as uppercase words in Figure 3-1 (see lines 1, 11 and 12) remain unchanged. Also lines 3 and 10 are always blank.

The current mode of operation is displayed in the lower right corner. In the figure, the name of the current mode is denoted by mmmmmmmm on line 13.

In addition to the current mode, other status information appears in the last line of the display. In the screen layout in the figure, asterisks are shown on line 13 under the five modem signal categories DTR, DSR, RTS, CTS, and CAR; however, an asterisk is not always present for each category. Two asterisks are usually present and the other three appear to be blinking on and off if data is currently being transmitted or received. The significance of each modem category is described in Table 3-4.

Table 3-4. Modem Signal Categories and Status Messages

Category	Definition	Status Message
DTR	Data Terminal Ready	If an asterisk is present, the microcode has been loaded in the Model 2228 controller by the emulation program, and the controller is now operational.
DSR	Data Set Ready	If an asterisk is present, the modem has been placed in the data position. Though the DSR asterisk must be present for data transmission/reception to take place, its presence does not always ensure the possibility. Depending upon the characteristics of the modem being used, the DSR asterisk may appear when the local modem is in the data position and the remote end has not yet completed the communications link (or has disconnected an already established link).
RTS	Request to Send	If an asterisk is present, the Model 2228 is signaling the modem that it desires to send data.
CTS	Clear to Send	If an asterisk is present, the modem is signaling the controller that the modem is ready to send data.
CAR	Carrier	An asterisk indicates a carrier is present, i.e., the sine wave which carries the transmitted or received signal is present.

Now, observe in Figure 3-1 that additional status information appears in the center of line 13. In particular, xxxx and yyyy represent the number of blocks sent and received, respectively. Initially, both these values are blank. No value appears in the position xxxx until the system enters the SEND mode for the first time and actually transmits data; then xxxx is set to 0000 and incremented by 1 as each block is transmitted. When the transmission is completed, the total number of blocks sent remains fixed -- the value of xxxx is not altered by entry into the CONTROL, RECEIVE, ATTENTION, or BID modes -- the value is not reset to zero until the system again enters the SEND mode in response to operator action.

Similarly, no value appears in the position yyyy until the system enters the RECEIVE mode in response to action from the remote end of the line. Then yyyy is set to 0000 and incremented by 1 after each block is received. When

reception is complete, the total number of blocks received remains fixed. The value of yyyy is not reset to zero until the system again enters the RECEIVE mode.

Other status information related to transmission and reception appears elsewhere on the CRT. See Table 3-5.

Table 3-5. Transmission/Reception Status Messages

CRT Location	Message*	Meaning
Line 4	SEND	The system is either sending or waiting to send non-binary data, i.e., data automatically translated into EBCDIC code.
	SEND TRANSPARENT	The system is either sending or waiting to send binary data (no translation is made).
	TRANSMISSION COMPLETED	The system has completed a send or send transparent operation.
	TRANSMISSION ABORTED	Transmission has been aborted in response to operator action at either end of the line.
Line 9	RECEPTION ABORTED	Transmission has been aborted in response to operator action at either end of the line.

* When the system returns to the CONTROL mode after transmission or reception is completed/aborted, any existing messages on lines 4 and 9 are not cleared since retention of the information removes the necessity for constant monitoring by an operator. By pressing S.F.'0 while the system is in the CONTROL mode, any such messages are removed.

Line 7 of the CRT displays device ready status messages only for the designated output device. If the receive device is a printer, a not ready condition produces the message PRINTER NOT READY; a ready condition produces no message. If the receive device is a disk, a not ready condition produces the message RECEIVE DISK FILE NOT OPENED; a ready condition produces the message RECEIVE FILE xxxxxxyy OPENED, where the first six characters are the operator-supplied file identifier and the last two characters are the sequential two-digit code supplied by the system.

After an operator presses S.F.'2 or S.F.'3 to initiate data transmission, device-related prompts appear on the CRT on line 5. Information requested by the prompts is summarized in Table 3-6.

Table 3-6. Device-dependent Information Required Upon Initiation of SEND or SEND TRSP

Input Device	Prompts Requiring Responses After S.F.'2=SEND or S.F.'3=SEND TRSP Activated
Card Reader	END OF FILE AT HOPPER EMPTY (1=YES)? READY CARD READER. KEY RETURN/EXEC TO CONTINUE Valid responses to the first prompt are as follows: a) Key 1 [EXEC] to answer yes. b) Key RETURN(EXEC) to answer no. The successive prompts appear initially and, also, after each hopper empty condition is sensed -- unless the condition occurs following a "yes" answer; then, the system returns to the CONTROL mode after transmitting the last batch of cards.
Disk (Method 2, Srch Calog)	ENTER SEND DEVICE ADDRESS AS 1=310 2=B10 3=320 4=B20 ENTER FILE NAME x Initially, x is 1. As soon as the operator supplies the name of a file to be transmitted, the system searches the catalog to determine the validity of the name. If not valid, the message RE-ENTER appears below the invalid name, and a new name is awaited. If valid, the system increments the value of x by 1 and requests the name of the next file to be transmitted. The process continues until the operator keys RETURN(EXEC) without supplying a name, or the value of x reaches 5 (or 10 if the program was generated for communication between two Wang systems). Then, the following prompt appears if x > 1: SEND FILES SEPARATELY OR COMBINED AS ONE (1=SEPARATE) Valid responses are as follows: a) Key 1 [EXEC] if the files are to be sent as separate messages (or files) within a single transmission. b) Key RETURN(EXEC) if the files are to be combined and sent as a single message (or file), thereby appearing to the remote end as though the files originated as a single file (or a stream of cards). Afterwards, the system enters the BID mode. Upon successful completion of the BID mode, the system enters the SEND mode and transmits the specified files before returning to the CONTROL mode. (If the BID mode is unsuccessful, or transmission is aborted, or line difficulties develop, the system returns to the CONTROL mode prematurely.)
Disk (Method 1, On Error)	ENTER SEND DEVICE ADDRESS AS 1=310 2=B10 3=320 4=B20 ENTER FILE NAME x Initially, x is 1. As soon as the operator supplies the name of a file to be transmitted, the system checks the catalog to determine the validity of the name. If not valid, the message STOP NAME NOT CATALOGUED appears below the invalid name. The operator must key S.F.'0 to return the system to the CONTROL mode, then key S.F.'2 or S.F.'3 and name the files from the beginning. If a file name is valid, the system increments the value of x by 1 and requests the name of the next file to be transmitted. The process continues until the operator keys RETURN(EXEC) without supplying a name, or x reaches 5 (or 10 if the program was generated for communication between two Wang systems). Then, the following prompt appears if x >1: SEND FILES SEPARATELY OR COMBINED AS ONE (1=SEPARATE) Valid responses are as follows: a) Key 1 [EXEC] if the files are to be sent as separate messages (or files) within a single transmission. b) Key RETURN(EXEC) if the files are to be combined and sent as a single message (or file), thereby appearing to the remote end as though the files originated as a single file (or a stream of cards). Afterwards, the system enters the BID mode. Upon successful completion of the BID mode, the system enters the SEND mode and transmits the specified files before returning to the CONTROL mode. (If the bid mode is unsuccessful, or transmission is aborted, or line difficulties develop, the system returns to the CONTROL mode prematurely.)

Error Messages

As indicated in Table 3-6, an error message may occur when the system is processing operator-supplied names of the disk files to be transmitted. Depending upon the disk method in effect for the communications program, an invalid file name produces the following message:

a) RE-ENTER, if Method 2 is in effect, or
b) STOP NAME NOT CATALOGUED, if Method 1 is in effect.

The recovery technique for Method 1 is described in Table 3-6.

As indicated in Table 3-3, an error message may occur during the ATTENTION mode when the system is processing the operator-supplied file identifier for receive-to-disk files. If Method 2 is in effect, the system searches the catalog index and accepts the identifier only if the 6 (or less) supplied characters are unique with respect to the first 6 (or less) characters in every currently catalogued name -- thereby ensuring the capability to open as many as 99 sequentially named files. On the other hand, if Method 1 is in effect, the system appends the characters 01 to the 6 (or less) supplied characters to create the first file name, and then checks the catalog for the uniqueness of only the first file name. An invalid file identifier produces the following message:

a) xxxxxx CATALOGUED RE-ENTER, if Method 2 is in effect, or
b) STOP NAME ALREADY CATALOGUED, if Method 1 is in effect.

The recovery technique for Method 1 is described in Table 3-3.

Other error messages may occur during the ATTENTION mode (or subsequently) when the system attempts to open a file and cannot do so because of space limitations on the disk.

For example, the message

a) INSUFFICIENT SPACE ON RECEIVE DISK, if Method 2 is in effect, or
b) STOP INSUFFICIENT SPACE ON RECEIVE DISK, if Method 1 is in effect,

can occur at the time the first file is being opened, or can occur when the system closes a file and attempts to open the next file.

To recover, the operator normally removes the platter having insufficient space and mounts a new, indexed platter at the same location. If Method 2 is in effect, the system is in the CONTROL mode; therefore, the operator should key S.F. '1 (ATTN) and supply a new file identifier for reception of additional files from the remote end. If Method 1 is in effect, key S.F. '0 followed by S.F. '1 and supply a new file identifier for reception of additional files.

If the system is in the RECEIVE mode and the file being received to disk overflows the allotted space, the following message code appears:

†ERR 62

whether Method 1 or 2 is in effect. Keep in mind, that Method 2 opens each receive file by temporarily allotting all the currently available space on disk to the file (and freeing any unused space when the file is closed); but Method 1 opens each receive file by allotting the exact number of sectors specified by the operator (and does not free any space when the file is closed).

The system remains in the RECEIVE mode if reception to disk is interrupted by a Code 62 error message. By keying S.F. '0 many times, the system may return to the CONTROL mode; however, such a procedure is not a recommended recovery method. Usually the operator should clear the system, reload the program, contact the remote end of the line to request retransmission of all files, and exercise care to provide ample space on the receiving disk platter.

At some point in the loading or operation of a 2780 emulation program, the message

SYSTEM ERROR!

may occur. If so, the operator must clear the system and reload the program. An operator should exercise caution to avoid one source of such an error - do not touch HALT/STEP followed by S.F. '0 when the system is in the SEND mode, as indicated in Section 3.4. (Do not touch RESET at any time during program operation.) If repeated attempts to operate the program produce a SYSTEM ERROR, call the Wang Service Representative.

3.7 TRANSMISSION/RECEPTION CONSIDERATIONS

Operator Action

In Section 3.3, the procedure for loading and starting a communications program is described. In other sections (3.4, 3.5, and 3.6), detailed information is given about the five operational modes by which a program provides two-way communications between a Wang system and a host computer or a terminal. The displays, prompts, status and error messages by which an operator is made aware of current system action (or required intervention) are described. Also, initial operator action relative to any receive device not ready message is discussed. The extensive detail in these earlier sections is provided in tables, in many cases, for reference purposes. Understandably, any reader using this manual for the first time may be overwhelmed by the detail at this point; however, once a reader is familiar with the scope and features of Wang's turnkey communications programs, operation of any program from the 2780 emulation utilities package should be straightforward.

Modem Match

In addition to operator action, some other considerations affect successful transmission and reception of data. In particular, as pointed out in Section 3.8, modems in use at both ends of a communications link must be compatible and most operate at the same line speeds. If a communications program enters the BID mode from CONTROL in response to operator action but continually fails to enter the SEND mode, the operator should inquire about

the modem compatibility -- if trying to establish a connection with a facility not previously contacted, and if sure that the communications link via the telephone lines has been completed.

Code Translation

If transmitting data which is stored in pure binary form or stored in EBCDIC code, initiate data transmission using only S.F. '3 (SEND TRSP). If transmitting data which is stored in ASCII form, either S.F. '2 (SEND) or S.F. '3 (SEND TRSP)can be used. The system does or does not perform a code translation as follows:

a) If S.F. '2 is used, the system assumes data is in ASCII form and automatically translates the data to EBCDIC form prior to transmission.

b) If S.F. '3 is used, no code translation occurs prior to transmission.

When data is received, the system recognizes whether the remote end is sending normally (in EBCDIC code) or transparently (in binary code) by the data-link control characters included as part of the 2780 line protocol. Data is translated from EBCDIC code to ASCII code before being output to the receive device if normal transmission from the remote end is detected; no translation occurs prior to output if transparent data is received.

The ASCII and EBCDIC code sets and translation of common and non-common characters are described in Appendix E.

The TC Format

Except as noted in Section 3.2, data stored on disk for subsequent transmission should be in Wang's TC format regardless of whether S.F. '2 or S.F. '3 is used to initiate the transmission. Similarly, data received for output to disk is stored in the TC format whether normal or transparent data is received.

Adequate Output Capacity

If receiving data for storage on disk, care should be exercised to ensure that sufficient space is available on the platter mounted at the receive device address. If receiving data for output to a printer, care should be exercised to ensure that an adequate supply of paper is in the printer rack, the printer is turned on, and selected.

3.8 ESTABLISHING A CONNECTION

An exact procedure for establishing a connection can not be given here since some details may vary with the type of modem and the handset being used at a particular installation. However, some general considerations are important:

1. Are the local and remote modems compatible?

   As indicated in Section 1.3, modems used at both ends of a point-to-point dial-up communications link must be of similar type. Therefore, successful communications with one or more host computers or one or more terminals does not ensure successful communications with every host computer or terminal. Determine the compatibility of the local and remote modems if attempting to communicate with a particular facility for the first time.

2. What telephone number should be called for actual data transfer, and what is the appropriate dialing procedure for hookup with another facility?

   At large data centers, different telephone numbers access different "ports". One port may accept the 2780 line protocol at a line speed of 2400 bps; another port may accept the 2780 line protocol at a line speed of 4800 bps; a third port may accept a different binary synchronous line discipline (e.g. 3741) at a particular speed; a fourth port may accept asynchronous line transmission at a particular speed. Thus, when obtaining the correct number to be used for hookup of a Wang system to a host computer system, be sure to determine the appropriateness of the number with respect to the line discipline and the transmission speed being used by the Wang system. (The transmission speed associated with particular modems is included in the descriptions given in Section 1.3.)

3. What telephone number should be called to ask questions, and what are the names of people who can supply answers?

4. What is the normal event sequence immediately after a connection is completed?

   a) Should the Wang system transmit first? If so, is a particular sign-on message required?

   b) Does the remote end normally transmit first? If so, is a particular message used? Is a response required?

5. What character set is used by the remote facility?

   As indicated in Section 3.4, the 2780 emulation programs provide the capability to transmit data normally (i.e., in EBCDIC character form) using S.F. '2 (SEND), or to transmit data transparently (i.e., in binary form) using S.F. '3 (SEND TRSP).

6. Have successful communications between the local and remote systems occurred previously? Is the same 2780 communications program to be used, or is a program generated with new options to be used?

NOTE:

Once successful communications with a particular facility have occurred, the step-by-step procedure (including all telephone numbers and names of people who can provide assistance) should be outlined and posted near the local system.

CAUTION:

Before establishing a connection with another facility, clear the Wang system; load and start the communications program; then, monitor the display until the last line indicates the system is in the CONTROL mode and an asterisk appears only under the modem signal DTR. Afterwards, use the appropriate dial-up procedure; now, an asterisk should appear under modem signal DSR (Data Set Ready) indicating the modem is in the data position and usually indicating a true connection has been established with the remote end.

3.9 A TYPICAL OPERATOR SEQUENCE FOR DISK FILE TRANSMISSION

The following diagram presents a typical example of operator action for disk file transmission. The diagram serves as a summary of some of the information presented in the preceding sections of Chapter 3.

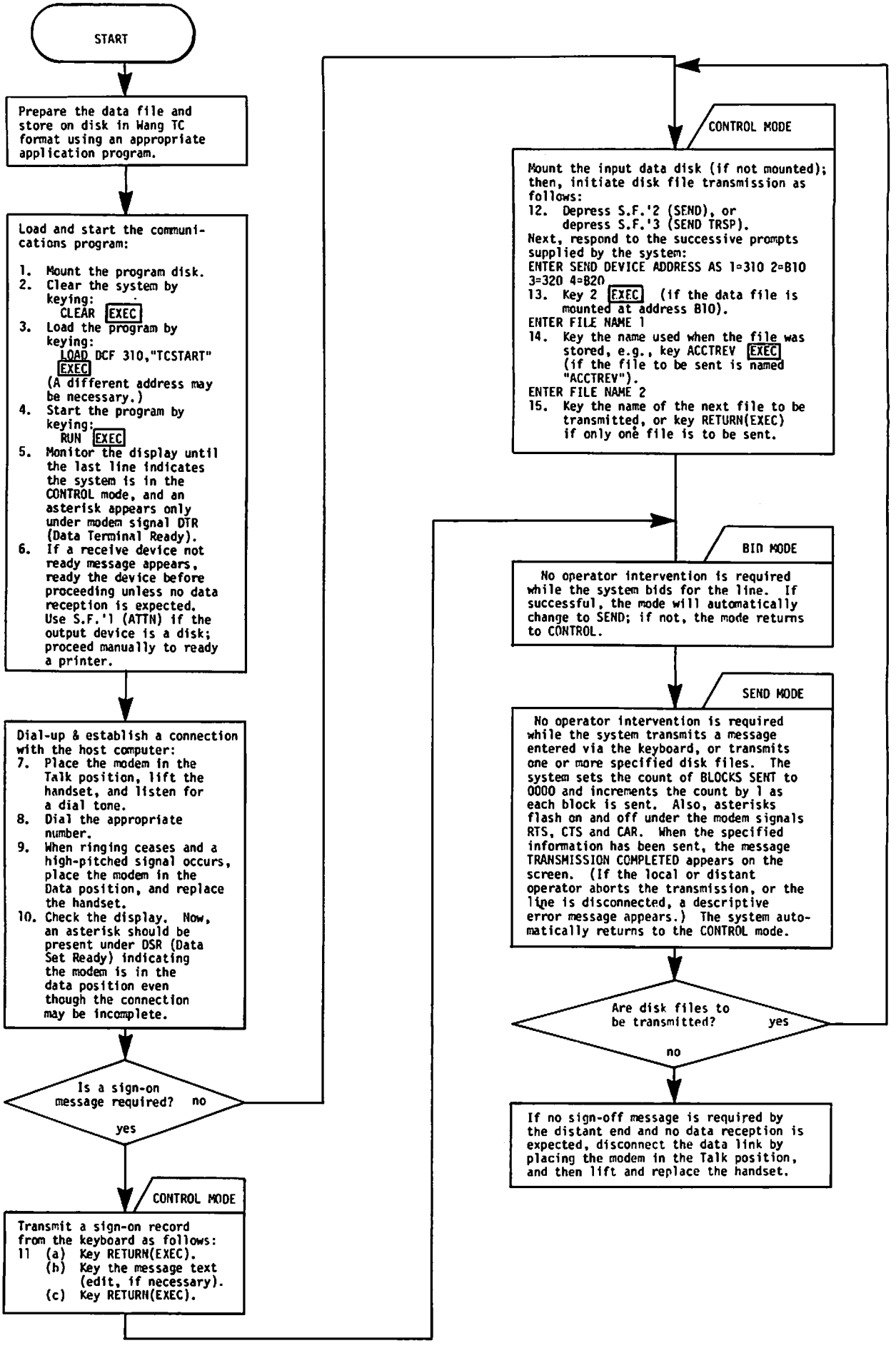


Figure 3-2. A Typical Operator Sequence for Disk File Transmission

APPENDIX A
CPU REQUIREMENTS

To run the SYSGEN program, the following CPU's with 12K bytes of memory can be used:

1. a 2200B with Options 2 and 5,
2. a 2200C with Options 2 and 5,
3. a 2200S with Option 24, or
4. a 2200T.

However, only 8K bytes of memory are necessary to run some communications programs, depending upon the I/O configuration and the disk file opening and closing method, as shown in Table A-1.

Table A-1. Memory Requirements for 2780 Emulation Programs

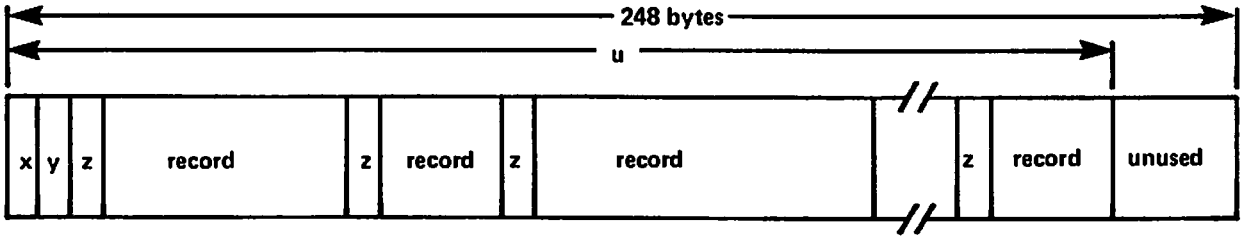
Input Device	Output Device	Disk File Method	Minimum Memory	Remarks
Card Reader	Printer	-	8K	
	Disk	1 (On Error)	8K	Not for 2200B
		2 (Srch Catlg)	12K	
	Disk & Printer	2 (Srch Catlg)	12K	
	Dummy/Testing	-	8K	
Disk	Printer	1 or 2	8K	
	Disk	1 (On Error)	8K	Not for 2200B
		2 (Srch Catlg)	12K	
	Disk & Printer	2 (Srch Catlg)	12K	
	Dummy/Testing	1 or 2	8K	
Dummy/Testing	Printer	-	8K	
	Disk	1 (On Error)	8K	Not for 2200B
		2 (Srch Catlg)	12K	
	Disk & Printer	2 (Srch Catlg)	12K	
	Dummy/Testing	-	8K	

APPENDIX B
THE TC FILE FORMAT

The "telecommunications (TC) format" for disk data files is defined as follows:

1. Records are packed into a one-dimensional alphanumeric array having four elements, each 62 bytes long, e.g., DIM A$(4)62. The array is saved into a single sector by using the DATASAVE DC or DATASAVE DA statements.

2. Within the 248 bytes of storage, three types of control bytes are used (see x, y and z in the following diagram).



x = the first byte in the array -- a one-byte hexadecimal code indicating whether the sector is or is not the last sector in the file; in particular, x=HEX(F0) denotes "is the last sector", x=HEX(00) denotes "not the last sector".

y = the second byte in the array -- a one-byte hexadecimal value denoting "the number of used bytes plus one" in the array. For example, in the diagram, y is the hexadecimal equivalent of the value u+1.

z = a one-byte hexadecimal value preceding each record to denote "the record length in bytes", where the maximum acceptable length for input files is 192 bytes. For example, if a record contains 39 bytes, z=HEX(27) since $(27)_{16}=(39)_{10}$.

record = one complete record -- individual records do not overlap from one 248-byte array to the next.

> NOTE:
>
> A standalone utility program called Data Entry 1 is available to allow the user to create TC formatted disk files or to edit, delete, rearrange, create, and list records in an existent TC formatted disk file. The program requires a 2200T processor with 16K bytes of memory, and a dual disk drive (either a hard disk or diskette drive). Data Entry 1 is part of the TC Support Utilities 1 package, originated by Wang Laboratories.

APPENDIX C
CHECKLIST -- SYSGEN 2780 EMULATOR

Checklist

SYSGEN 2780 EMULATOR

A. THE SYSGEN PROGRAM WAS JUST LOADED FROM

1 DISK UNIT 310 _____
2 DISK UNIT B10 _____
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

B. THE GENERATED SYSTEM WILL BE CREATED ONTO

1 DISK UNIT 310 _____ (A hard disk or diskette
2 DISK UNIT B10 _____ drive can be used.)
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

C. GENERATED SYSTEM WILL BE LOADED FROM

1 DISK UNIT 310 _____
2 DISK UNIT B10 _____
3 DISK UNIT 320 _____
4 DISK UNIT B20 _____

D. DATA WILL BE TRANSMITTED FROM

1 DISK _____ (DISK = any hard disk or
2 CARD READER _____ diskette drive; any reply
3 DUMMY FOR TESTING _____ allows keyboard input.)

E. RECEIVED DATA WILL BE OUTPUT TO

1 DISK _____ (DISK = any hard disk or
2 LINE PRINTER _____ diskette drive.)
3 DISK & PRINTER _____ (Reply 3 emulates
4 DUMMY FOR TESTING _____ punch/print reception.)

F. WHEN OPENING AND CLOSING DISK FILES, SYSTEM SHOULD USE

1 METHOD 1 (ON ERROR) _____ (Method 2 is recommended.
2. METHOD 2 (SRCH CATLG) _____ See Table 2-1.)

G. TYPE OF MODEM TO BE USED IS

1 201A, 201C, or 208B _____
2 202C or 202S _____

H. DATA WILL BE TRANSMITTED BETWEEN THIS SYSTEM AND

1 ANY OTHER COMPUTER _____ (If the answer to E is 2
2 A WANG 2200 SYSTEM _____ or 3, use reply 1 only.
See Table 2-1.)

I. WHEN TRANSMITTING, CONTROLLER WILL BLOCK DATA INTO

1 MULTI-RECORD BLOCKS _____ (Question I is omitted if the
2 SINGLE RECORD BLOCKS _____ answer to H is 2.)

APPENDIX D
COPYING AN EMULATOR PACKAGE FROM CASSETTE TO DISK

If Wang's IBM 2780 Emulator Utilities Package for the Model 2228 controller is obtained as a disk image on cassette package, the version must be copied to a disk before use.

The disk image on cassette package consists of two cassettes numbered one and two. A special loader program is recorded at the beginning of cassette one. The loader program provides prompts to simplify the operation of copying (or updating) from cassette to disk.

For initial copying, indexed disks are mounted at both the F and R locations of a disk unit -- as indicated in Step 3 of the instructions which follow. For updating, an indexed disk is mounted at the F location and the disk containing the software system to be updated is mounted at the R location.

> NOTE:
>
> The copy/update procedure implemented by the special loader program in the cassette package uses the fixed disk as a scratch disk. Threfore, if the disk at the F location currently contains any valuable files, make a backup copy of the disk before copying or updating a disk-image-on-cassette software system from cassette to disk.

	DISPLAY	INSTRUCTIONS
1.	(None)	1. If updating a software system, first make a backup copy of the disk to be updated. Now, to copy/update, mount cassette one at address 10A. Then key: CLEAR (EXEC) LOAD (EXEC) RUN (EXEC)
2.	ENTER THE DESIRED DISK ADDRESSES ?_/ 0 - 310/B10 1 - 320/B20 2 - 330/B30	2. Enter the number corresponding to the disk addresses to which files are to be copied/updated.

3.	MOUNT DISK TO BE UPDATED IN REMOVABLE DRIVE. KEY RETURN(EXEC) TO RESUME	3. For initial copying, mount indexed disks in both the F and R locations corresponding to the addresses selected in Step 2. For updating, mount the disk to be updated at the R location and an indexed disk at the F location corresponding to the addresses selected in Step 2.
4.	DO YOU HAVE A BACK-UP COPY (YES/NO)	4. Enter YES if a backup copy of the software system to be updated, as well as a backup copy of valuable files at the fixed disk location, have already been made. Otherwise, enter NO.
5.	(processing displays)	5. Several processing displays indicate the operation currently being performed. No operator intervention is required.
6.	MOUNT NEXT TAPE - UNIT 10A KEY RETURN(EXEC) TO RESUME.	6. If this message appears, mount the next cassette at address 10A. Then, key RETURN(EXEC).
7.	END PROGRAM	7. The copying/updating operation is complete. Both mounted disks contain complete copies of the copied/updated files.

APPENDIX E
CODE TRANSLATION

The binary synchronous communications procedures supported by Wang systems accommodate two specific 8-bit transmission code sets:

- EBCDIC (Extended Binary Coded Decimal Interchange Code) having 256 assignment positions.
- USASCII (United States of America Standard Code for Information Interchange) having 128 assignment positions.

The USASCII code set is also referred to as the ASCII code set. See Tables E-1 and E-2.

When either of these two code sets is used with transparent mode, the flexibility of the communications system is increased further since all 256 possible 8-bit configurations are treated as "data only" and no control or graphic significance is associated with any 8-bit configuration. Thus, the parity bit is also available as a data bit when transmitting transparent USASCII-coded data. Furthermore, within the standard message format, any type of coded information can be handled in transparent-text mode.

ASCII to EBCDIC Code Translation

Before transmission in the standard mode (non-transparent), data is converted from ASCII to EBCDIC as follows:

1. The following characters are converted to NUL codes to avoid possible interference with data-link control characters: RS (IRS), US (IUS), ETB, ETX, ENQ, SYN, DLE.

2. All other ASCII control characters have EBCDIC counterparts and are converted to the equivalent EBCDIC code: ACK, SOH, STX, EOT, NAK, NUL, SUB, ESC, DEL, BEL, EM, FS (IFS), GS (IGS), SP, BS, HT, CR, LF, VT, FF, SO, SI, DC1, DC2, DC3, DC4.

3. ASCII graphic characters having EBCDIC counterparts are converted to the equivalent EBCDIC code:

   a) Alphanumeric characters:
      A through Z, a through z, 0 through 9.

   b) Punctuation symbols:
      . ? : ; , " '

   c) Common special graphics:
      # $ % & * / @ + - = ( ) _

   d) Other special graphics:
      < > { } \ ` (grave accent) ~ (tilda) ¦ (split vertical line)

4. ASCII graphic characters having no EBCDIC counterparts are converted as follows:

ASCII graphic	EBCDIC character
↑ (up-arrow)	¬ (logical NOT symbol)
[(left bracket)	¢ (cent sign)
] (right bracket)	! (logical OR symbol)

EBCDIC to ASCII Code Translation

After reception in the standard mode (non-transparent), data is converted from EBCDIC to ASCII as follows:

1. EBCDIC control characters having no ASCII counterparts are converted to NUL codes: PF, LC, RLF, SMM, RES, NL, IL, CC, DS, SOS, RS, BYP, SM, FS, PN, UC.

2. EBCDIC characters having no control or graphic assignments are converted to NUL codes.

3. EBCDIC control and graphic characters having ASCII counterparts are converted to the equivalent ASCII code. (See the characters listed under 2 and 3 in the ASCII-to-EBCDIC translation list.) The characters RS(IRS), US(IUS), ETB, ETX, ENQ, SYN, DLE are not legal data characters and do not occur in received data.

4. EBCDIC graphic characters having no ASCII counterparts are converted as follows:

EBCDIC graphic	ASCII character
¬ (logical NOT symbol)	↑ (up-arrow)
¢ (cent sign)	[(left bracket)
! (logical OR symbol)	] (right bracket)

NOTE:

Wang CRT's and printers use the ASCII code set. Some peripherals may not display all EBCDIC or ASCII graphic characters. Furthermore, substitute graphic characters may be displayed. For details, refer to the manual which accompanies the particular peripheral.

Table E-1. ASCII Code*

High order 4 bits / Low order 4 bits		0_{0_0}	0_{0_1}	0_{1_0}	0_{1_1}	1_{0_0}	1_{0_1}	1_{1_0}	1_{1_1}
		0	1	2	3	4	5	6	7
0_{0_0}	0	NUL 0	SOH 1	STX 2	ETX 3	EOT 4	ENQ 5	ACK 6	BEL 7
0_{0_1}	1	DLE 16	DC1 17	DC2 18	DC3 19	DC4 20	NAK 21	SYN 22	ETB 23
0_{1_0}	2	Space 32	! 33	" 34	# 35	$ 36	% 37	& 38	(apos.) ' 39
0_{1_1}	3	0 48	1 49	2 50	3 51	4 52	5 53	6 54	7 55
1_{0_0}	4	@ 64	A 65	B 66	C 67	D 68	E 69	F 70	G 71
1_{0_1}	5	P 80	Q 81	R 82	S 83	T 84	U 85	V 86	W 87
1_{1_0}	6	grave accent ` 96	a 97	b 98	c 99	d 100	e 101	f 102	g 103
1_{1_1}	7	p 112	q 113	r 114	s 115	t 116	u 117	v 118	w 119

High order 4 bits / Low order 4 bits		1_{0_0}	1_{0_1}	1_{0_2}	1_{0_3}	1_{1_0}	1_{1_1}	1_{1_2}	1_{1_3}
		8	9	A	B	C	D	E	F
0_{0_0}	0	BS 8	HT 9	LF 10	VT 11	FF 12	CR 13	SO 14	SI 15
0_{0_1}	1	CAN 24	EM 25	SUB 26	ESC 27	FS 28	GS 29	RS 30	US 31
0_{1_0}	2	(40	) 41	* 42	+ 43	(comma) , 44	(dash) - 45	(period) . 46	/ 47
0_{1_1}	3	8 56	9 57	: 58	; 59	< 60	= 61	> 62	? 63
1_{0_0}	4	H 72	I 73	J 74	K 75	L 76	M 77	N 78	O 79
1_{0_1}	5	X 88	Y 89	Z 90	[91	\ 92	] 93	↑ 94	(underline) _ 95
1_{1_0}	6	h 104	i 105	j 106	k 107	l 108	m 109	n 110	o 111
1_{1_1}	7	x 120	y 121	z 122	{ 123	| 124	} 125	~ 126	DEL 127

*Numbers in the lower right corner of each box represent the decimal equivalent of the binary and the hexadecimal code for the character shown in the box, e.g., A = $(41)_{16} = (01000001)_2 = (65)_{10}$.

Table E-2. EBCDIC Code*

High-order 4-bits \ Low-order 4-bits (hex digit)	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL 0	SOH 1	STX 2	ETX 3	PF 4	HT 5	LC 6	DEL 7	8	RLF 9	SMM 10	VT 11	FF 12	CR 13	SO 14	SI 15
0001	1	DLE 16	DC1 17	DC2 18	DC3 19	RES 20	NL 21	BS 22	IL 23	CAN 24	EM 25	CC 26	27	IFS 28	IGS 29	IRS 30	IUS 31
0010	2	DS 32	SOS 33	FS 34	35	BYP 36	LF 37	ETB 38	ESC 39	40	41	SM 42	43	44	ENQ 45	ACK 46	BEL 47
0011	3	48	49	SYN 50	51	PN 52	RS 53	UC 54	EOT 55	56	57	58	59	DC4 60	NAK 61	62	SUB 63
0100	4	Space 64	65	66	67	68	69	70	71	72	73	¢ 74	(period) . 75	< 76	(77	+ 78		79
0101	5	& 80	81	82	83	84	85	86	87	88	89	! 90	$ 91	* 92	) 93	; 94	¬ 95
0110	6	(dash) - 96	/ 97	98	99	100	101	102	103	104	105	¦ 106	(comma) , 107	% 108	(underline) _ 109	> 110	? 111
0111	7	112	113	114	115	116	117	118	119	120	grave accent ` 121	: 122	# 123	@ 124	(apos.) ' 125	= 126	" 127
1000	8	128	a 129	b 130	c 131	d 132	e 133	f 134	g 135	h 136	i 137	138	139	140	141	142	143
1001	9	144	j 145	k 146	l 147	m 148	n 149	o 150	p 151	q 152	r 153	154	155	156	157	158	159
1010	A	160	~ 161	s 162	t 163	u 164	v 165	w 166	x 167	y 168	z 169	170	171	172	173	174	175
1011	B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
1100	C	{ 192	A 193	B 194	C 195	D 196	E 197	F 198	G 199	H 200	I 201	202	203	204	205	206	207
1101	D	} 208	J 209	K 210	L 211	M 212	N 213	O 214	P 215	Q 216	R 217	218	219	220	221	222	223
1110	E	\ 224	225	S 226	T 227	U 228	V 229	W 230	X 231	Y 232	Z 233	234	235	236	237	238	239
1111	F	0 240	1 241	2 242	3 243	4 244	5 245	6 246	7 247	8 248	9 249	250	251	252	253	254	255

*Numbers in the lower right corner of each box represent the decimal equivalent of the binary and the hexadecimal code for the character shown in the box, e.g., A = $(C1)_{16}$ $(11000001)_2$ = $(193)_{10}$.

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