Chapter 6   SEQUENTIAL ACCESS USING DEVICE FILES

This Chapter describes procedures for sequential access to RS-232C serial communications interfaces, the CMOS RAM file, or a printer connected to the QX-10.

6.1 RS-232C Interface Support

RS-232C interface support is a standard feature of QX-10 MFBASIC. The QX-10 is equipped with one RS-232C interface as standard equipment, and a maximum of four additional RS-232C ports can be utilized by installing optional RS-232C interface cards.

The RS-232C ports are handled as sequential input/output devices, and are identified by the device names "COM0:" to "COM4:". Statements and functions which can be used with the RS-232C interfaces are as follows.

(1) Statements
     OPEN, CLOSE, INPUT #, LINE INPUT #, PRINT #, PRINT # USING
(2) Functions
     EOF, LOF, INPUT$

NOTE:
The size of the receive buffer used for RS-232C communications is 1024 bytes.

6.1.1   Opening the RS-232C interface

RS-232C interface ports are opened for data communications by executing an OPEN statement. The parameters of this statement specify which interface port is to be opened (COM0: to COM4:), the mode in which it is to be opened (input or output), the file number which is to be assigned to the device, and the communication format and control options. The communications format and control options are specified in the OPEN statement as a string of up to seven characters, each of which determines the setting of one of seven communications options. The format for specification of the OPEN statement and the meanings of the various communications options are described in detail below.

(1)   OPEN statement
The general format of the OPEN statement for opening the RS-232C interface ports is the same as that used when opening sequential access files on flexible disks; however, the format of the < file descriptor > differs slightly as shown below.

For disk files   For RS-232C interfaces
"[< device name > :] < filename >]   " < device name > :[(< options >)"]

(a)   Device
One of the following device names must be specified in the file descriptor of the OPEN statement when opening an RS-232C interface port.

COM0: ---	Standard RS-232C interface
COM1:	
to	Expansion RS232C interfaces
COM4:	(Specifiable only when an optional interface card is installed.)

(b) Options

The <options> specification in the OPEN statement determines the data communications format and the control options. These are specified as a character string of up to seven characters, each of which determines the setting of one option. The general format of the string specifying these options is (blspcxh), where "b" specifies the bit rate (communication speed), "1" specifies the word length (the number of bits which are used to represent each character of data), "p" specifies the type of parity check to be made, "s" specifies the number of stop bits between characters, and "c" specifies which of the interface's four control lines are to be checked when the interface is opened or during data communications. The "x" option specifies whether or not communication is to be controlled according to XON/XOFF protocol, and the "h" option indicates whether the shift-in/shift-out sequences are to be used for control. The characters specified for each option and their meanings are as described below.

b---   A hexadecimal integer from &H0 to &HF which determines the bit rate as follows.

0 -	50 bps	8 -	600 bps
1 -	75 bps	9 -	900 bps
2 -	110 bps	A -	1200 bps
3 -	125 bps	B -	1800 bps
4 -	150 bps	C -	2400 bps
5 -	200 bps	D -	4800 bps
6 -	300 bps	E -	9600 bps
7 -	400 bps	F -	19200 bps

(Cannot be specified for COM0:)

1---   A number from 6 to 8 which determines the number of bits per character.

6: 6 bits/character
7: 7 bits/character
8: 8 bits/character

p---   A letter which determines the type of parity check to be made.

N: None
E: Even parity
0: Odd parity

s---   A number which determines the number of stop bits to be included between each character.

1: 1 bit
2: 1.5 bits
3: 2 bits

c---	A hexadecimal digit from 0 to F; the 4 bits of this digit determine which of the four control lines are to be checked as follows.

        Bit 3---Auto enable (CTS send/CD receive check)
            1: OFF
            2: ON
        Bit 2---Data Set Ready (DSR) send check
            1: OFF
            0: ON
        Bit 1---Data Set Ready (DSR) receive check
            1: OFF
            0: ON
        Bit 0---Carrier Detect (CD) check
            1: OFF
            0: ON

x---	A letter which determines whether XON/XOFF protocol is to be used for communications control. (XON/XOFF control may be required when communication and other processing are performed concurrently.)

    X: XON/XOFF protocol used for control.
    N: XON/XOFF protocol not used for control.

h---	A letter which determines whether the shift-in/shift-out control sequences are to be used. (Shift-in/shift-out control cannot be used if the word length is other than 7 bits.)

    S: Shift-in/shift-out control used.
    N: Shift-in/shift-out control not used.

Any of the options in the (blpscxh) specification may be omitted, but if any following options are to be specified, the option omitted must be indicated with a space. When "blps" are omitted, the default values are those which have been set with the CONFIG transient command of CP/M. If "c", "x", and "h" are omitted, the default value is "F".

(2) OPEN modes

The RS-232C interface can be opened in either the "I" or "O" mode. The "I" mode is specified for input and the "O" mode is specified for output. If both input and output are to be performed, the device must be opened as two files, one for input and one for output. In such cases, the communications format and control options used are those specified in the first OPEN statement executed; the options will be ignored if they are included in the file descriptor of the second OPEN statement.

Example

```
10 OPEN "I",#1,"COM0:(68N3F)"
20 OPEN "O",#2,"COM0:(38E2F)"
     .
     .
100 PRINT #2,A$
110 INPUT #1,B
```

In the example above, (38E2F) is interpreted as (68N3F).

(2) Control lines
The control lines used for communications through the RS-232C interface are as follows.

(a) DTR (Data Terminal Ready)
DTR is a signal which is output by the QX-10 to indicate that it is ready for data communications. The level on this signal line becomes high when the interface is opened, regardless of whether it is opened in the "I" or "O" mode. The level becomes low when the interface is closed.

(b) RTS (Request To Send)
RTS is a signal which controls operation of a communication device (modem or acoustic coupler) connected to the QX-10. This line becomes high when the interface is opened in the "O" mode, and becomes low when the interface is closed.

(c) DSR (Data Set Ready)
DSR is a signal which indicates whether a communication device connected to the QX-10 is ready for operation. When high, the device is connected to the interface cable and is ready to accept signals controlling data transmission/reception.

(d) CD (Carrier Detect)
This line is used for detecting the data carrier signal from the connected device.

6.1.2   Output to the RS-232C interface

Data can be output to an RS-232C port with the following statements.

    PRINT #
    PRINT # USING

The format in which data is output to the RS-232C port by these statements is the same as for output to a disk drive.

(1) Control line checks for the "O" mode

(a) CTS
When auto enable is OFF (when bit 3 of option "c" is 1), data is output to the RS-232C port regardless of the CTS level. When auto enable is ON, data is output to the RS-232C port after checking CTS and waiting for it to become high.

(b)   DSR

When the DSR transmission check bit is OFF (when bit 3 of option ''c'' is 1), data is output to the RS-232C port regardless of the DSR level. When the output DSR check is ON, data is output after checking the DSR line and waiting for it to become high.

(2)   Errors applicable to the ''O'' mode

(a)   Device unavailable

This error occurs if an attempt is made to open ''COM1:'' to ''COM4:'' and the corresponding option card is not installed.

(b)   Device time out

This error occurs when transmission is not enabled (i.e., when the CTS or DSR level does not become high) within a certain period of time after the OPEN''O'' statement is executed with the auto enable or DSR transmission check bits of option ''c'' (bits 3 and 2) set to ON. This error also occurs if the BREAK key is pressed while transmission is being deferred for some reason.

6.1.3 Input from the RS-232C interface

The following statements and functions are used for input from the RS-232C interface.

Statements	Functions
INPUT #	INPUT$
LINE INPUT #	

The format in which data is input from the interface by these statements is the same as in the case of input from disk files.

Since the INPUT# and LINE INPUT# statements require specific delimiter and termination symbols, they do not provide full freedom of format. However, the INPUT$ function permits input regardless of delimiter and termination symbols and, when used together with the EOF or LOF functions, allows input regardless of format.

(1)   Control line checks for the ''I'' mode

(a)   DSR
If the DSR bit is set to ON (if bit 1 of option ''c'' is set to 0), the DSR line is checked at the time of execution of an OPEN''I'' statement for an RS-232C interface port, and the port is not opened until the DSR line becomes high. An error is generated if the level of this line becomes low during input.

(b)   CD
If the auto enable bit is set to ON (if bit 3 of option ''c'' is set to 0), the CD line is checked at the time of execution of an OPEN''I'' statement for an RS-232C interface port, and the port is not opened until the CD line becomes high. An error is generated if the level of this line becomes low during input.

(2)   Errors applicable to the ''I'' mode

(a)   Device unavailable
This error occurs when an attempt is made to open ''COM1:'' to ''COM4:'' and the corresponding option card is not installed.

(b)   Device time out
This error occurs when DSR does not become high within a certain period of time after an OPEN''I'' statement is executed with the DSR bit of option ''c'' set to ON (0). The same is true if CD does not become high within a certain period of time after an OPEN''I'' statement is executed with the CD bit of option ''c'' set to ON (0).

(c)   Device fault
This error occurs if the level of the DSR or CD line becomes low during input from the RS-232C interface while the DSR receive or CD check bits of option ''c'' are set to ON (0).

(d)   Device I/O error
This error occurs if a parity error, overrun error, or framing error is encountered during input from the RS-232C interface. Although the error condition will be reset if input is continued, there is no assurance that the data received into the receive buffer will be normal.

(e)   Input past end
This error occurs if the BREAK key is pressed while awaiting input from an RS-232C interface with INPUT #, INPUT$, or the like.

6.1.4 RS-232C functions

The four functions related to the RS-232C interface are as follows.

```
EOF
LOC
LOF
INPUT$
```

(1)　EOF (< file no. >)
This function returns TRUE (-1) when the receive buffer is empty, and FALSE (0) when it is not empty.

(2)　LOC (< file no. >)
This function returns the number of bytes received into the receive buffer.

(3)　LOF (< file no. >)
This function returns the number of bytes remaining in the receive buffer.

(4)　INPUT$ (< no. of characters > , < file no. >)
This function inputs the specified < no. of characters > from the RS-232C interface and returns them as a character string.

6.1.5　Using the LOAD, SAVE, and LIST commands with the RS-232C interface

Programs can be output via the RS-232C interface in ASCII format by using LIST ''COMn:'' or SAVE''COMn:'',A. When this is done, CTRL-Z (&HlA, an end mark) is output after transmission of the program has been completed.

When an ASCII program is loaded through the RS-232C interface with LOAD ''COMn:'', loading is terminated when CTRL-Z is encountered; the same applies when the program is loaded using RUN ''COMn:''. Although MFBASIC will continue to stand by for input from the RS-232C interface if CTRL-Z is not received for some reason, loading can be terminated by pressing the BREAK key.

NOTE:
A word length of 8 bits must be used for transfer of program lists; also, note that it is not possible to output or load programs via the RS-232C interface in binary format.

6.2 CMOS RAM

QX-10 MFBASIC supports sequential access to non-volatile CMOS RAM which is backed up by a built-in battery. This CMOS RAM is handled as a sequential device file, and has a capacity of about 2K bytes. The device name assigned to CMOS RAM is "CMOS:"; file names cannot be assigned to data stored in this device. The statements and functions which can be used with "CMOS:" are as follows.

(1) Statements
The statements which can be used for access to the CMOS RAM file are as follows.

```
OPEN, CLOSE, INPUT # , LINE INPUT # , PRINT # , PRINT # USING,
LIST, SAVE, LOAD, MERGE
```

(2) Functions
The functions which can be used for access to the CMOS RAM file are as follows.

```
LOC, LOF, EOF, INPUT$, SPC, TAB
```

(a) EOF
This function returns "0" when the CMOS file contains characters awaiting input, and "-1" if the CMOS RAM file is empty.

(b) LOF
This function returns the size of the CMOS file.

(c) LOC
This function returns the number of bytes read in from the CMOS RAM file since it was OPENed.

Opening the CMOS RAM file

The CMOS RAM file can be opened in either the ''I'' or ''O'' mode. When it is opened in the ''I'' mode, input by subsequent input statements starts at the beginning of the file.
When it is opened in the ''O'' mode, the file is cleared and output by subsequent output statements starts at the beginning of the file. A short program illustrating use of the CMOS RAM file is shown below.

```
10 OPEN"O",#1,"cmos:"
20 FOR I=1 TO 100
30 PRINT#1,STR$(I)
40 NEXT I
50 CLOSE
60 OPEN"I",#2,"cmos:"
70 IF EOF(2) THEN 110
80 INPUT#2,A$
90 PRINT A$;" ";
100 GOTO 70
110 CLOSE
Ok
RUN
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
Ok
```

Note that an ''Illegal function call'' error will occur if the CMOS file is already being used when the OPEN statement is executed, or if an attempt is made to output data to the CMOS file when it was already full.

NOTE:
The CMOS RAM file is backed up by battery, allowing it to be used during processing for data backup against the eventuality of power failure. However, it should be noted that the contents of the CMOS RAM file will be incomplete if a power failure occurs during output to the file with statements such as PRINT# or PRINT# USING. (The file is closed; however, data output up to the time of the power failure can be input when the power is restored.) Use of one of the following procedures is suggested to ensure the integrity of data input from the CMOS RAM file after a power failure has occurred.

(1)   Use a machine language routine to inhibit interrupts before executing the PRINT# or PRINT# USING statement, then reenable interrupts after execution is completed. This will prevent output from being interrupted if a power failure occurs.

(2)   Write two flags at the end of data output to the file and construct the program so that it will not use data input from the CMOS RAM file unless both flags are present.

6.3 Printer

With MFBASIC, a printer connected to the QX-10 can be accessed as a sequential output device. The device name under which the printer is opened for sequential output is "LPT0:". Opening the printer as a file makes it possible to print out data using statements such as OPEN# and PRINT#, as well as the LLIST and LPRINT statements. When the printer is opened as a file, the statements and functions which can be used are as follows.

6.3.1 Output to the printer

The following statements are used for output to the printer.

    OPEN#, PRINT#, PRINT#USING, CLOSE, LLIST, LIST "<device name>"

6.3.2 Functions

The four functions related to printer output are as follows.

    SPC, TAB, POS, LPOS

6.3.3 Errors

Errors which may occur during output to the printer are as follows.

(1) Device I/O error
This error occurs if the printer power is off or the printer is not operating normally.

(2) Device time out
This error occurs if the printer is in the offline condition.

(3) Out of paper
This error occurs if the printer runs out of paper or is not connected.