

ACORNSOFT

Termulator

on the BBC Microcomputer



Termulator

The Termulator software was written by Ken Blanshard, Brian Williams and Simon Barnes at The University of Sussex.

This manual was written by Katy Edgcombe.

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Note: Within this publication the term 'BBC' is used as an abbreviation for 'British Broadcasting Corporation'.

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1 The Termulator ROM

The Termulator ROM is designed to convert a BBC Microcomputer into a terminal which can communicate with other computers and computer networks.

Equipped with this ROM, your BBC Microcomputer can emulate a variety of standard terminals from a simple Teletype to a sophisticated ANSI-compatible (VT100) or Tektronix graphics terminal. You can use it to draw graphs and pictures as well as receiving text output. You can also send text or pictures to a suitable printer, and can transfer files of information between your BBC Microcomputer and other computers.

This manual explains how to use your BBC Microcomputer as a terminal. Some of the details you will need depend not on the terminal but on the computer or computer system you are connected to (your 'host system'), and so you will need to consult the manuals or experts on your host system as well as this User Guide.

For certain details you will also need to refer to the *BBC Microcomputer System User Guide*, but you do not need to know very much about the other uses of a BBC Microcomputer in order to use Termulator.

2 Equipment

The equipment you need in order to use Termulator consists of:

- A BBC Microcomputer Model B fitted with version 1.2 (or later) of the operating system (to find out what operating system a given BBC Microcomputer has, type *FXØ).
- A monitor or TV screen. Colour is not normally relevant (unless you plan to use the terminal in the special ‘BBC’ mode, see below). Since the terminal emulators normally use an 80-character screen width, a TV screen may not provide enough resolution; a monitor is preferable.
- A Termulator ROM, suitably fitted (for fitting instructions see the separate leaflet).
- A cable to plug into the RS423 socket at the back of your BBC Microcomputer.
- Some means of connecting the other end of this cable to your host computer. This may be simply a socket (if you have a wired connection to the host), or a modem or acoustic coupler to connect to the host via a telephone line. See Appendix G for full details of the RS423 connections.

If you have disc drives attached to your BBC Microcomputer, or an Econet interface, this may be useful, but it is not necessary to have any local ‘filing system’.

If you have a printer, you can use it in conjunction with Termulator to produce printouts of files held on the host computer, for instance, or a ‘hard copy’ record of your terminal session. If the printer is of a suitable type (Epson-compatible), you can also use it to reproduce graphs or pictures drawn on your screen in the course of your terminal session.

The printer must be connected via the parallel interface (Centronics interface), since the RS423 socket is used to link up with the host. See the *BBC Microcomputer System User Guide* for details of printer connections.

Termulator only uses the input/output facilities of the BBC Microcomputer, and it is not designed to work with a second processor attached by way of the ‘Tube’ interface. If you have a second processor, it should be switched off before using Termulator, and a ‘hard reset’ performed (hold down CTRL and press BREAK).

3 Starting Termulator

If your Termulator chip has been installed in the highest priority 'sideways ROM' position in your BBC Microcomputer (see installation leaflet), when you switch the machine on it will immediately enter Termulator. Otherwise (if, for instance, you have the BASIC chip in the priority position) you can enter Termulator by typing

`*TERMULATOR`

or

`*TERM.`

(note the full stop which must be typed).

Once within the terminal emulator, you can enter any other ROM system you have installed by issuing the usual `*` commands (eg `*BASIC` to enter BASIC), but the recommended way to leave the emulator is by pressing the CTRL and BREAK keys together (a 'hard reset' in User Guide terminology). This will restore BASIC or whichever system is entered when you switch on; however, if you enter Termulator again it will 'remember' your SETUP options.

The presence of the Termulator ROM does not affect the use of your BBC Microcomputer for other purposes such as BASIC programming or word processing (with the minor exception that it raises the standard level of PAGE; see the *BBC Microcomputer System User Guide*). However, when you enter Termulator, other information such as a BASIC program stored in memory at the time may be destroyed.

4 The main menu

When the terminal emulator is entered, it starts by displaying a ‘menu’ of actions for you to choose from. You choose an item by typing its number as given. Normally when you switch on your terminal you will need to start by selecting **SETUP** (see chapter 6), and when you have finished the setting-up process you will return to the main menu again to choose the next action.

At any time when you are using Termulator, you can call up the main menu again simply by pressing the **BREAK** key. This is useful if in the middle of a session you want to transfer a file to or from the host, say, or to change a **SETUP** option. Calling up the main menu does not normally interrupt your ‘conversation’ with the host computer; you can take it up again where you left off. Typing **Z** when in **SETUP** returns you to the main menu, and you can then reselect whichever terminal you were using.

Items 2 to 7 on the main menu give you the choice of various types of terminal (see below). Item 8 allows you to transfer a file from a BBC Microcomputer filing system (disc, Econet, etc, but not cassette tape) to the host computer, and vice versa.

The one item on the main menu which is not selected by typing a number is the last, **OS** command. Instead of typing a number, you can type in any Operating System command by starting with a *****. See the *BBC Microcomputer System User Guide* and the *Disc Filing System User Guide*, etc, for details of these commands. For instance, you could catalogue the contents of a disc using ***CAT** without interrupting your terminal session, or issue a ***SPOOL** command (see chapter 17). If an error occurs while an Operating System command is being processed, an error message will be displayed on the screen. You may need to press **BREAK** to get back to the main menu.

Two special ‘*****’ commands are provided with Termulator. They are ***SCDUMP**, for ‘dumping’ a screenful of information or pictures onto an Epson-compatible printer, and ***REPLAY**, which can replay on to the screen a picture drawn on disc during a terminal session and recorded on disc using the ***SPOOL** command. More details of both these commands are given in later chapters.

Note that you cannot type numbers, to choose items from the menu, if **SHIFT LOCK** is on; entering the main menu switches **SHIFT LOCK** off and **CAPS LOCK** on, but if you accidentally press **SHIFT LOCK** you should cancel it by pressing it again or using **CAPS LOCK**.

5 The terminal emulators

The choice of terminal emulator depends very much on the host computer and on the programs or utilities you expect to use. Many 'mainframe' computers have programs (editors, graphics programs and so on) specifically designed for one particular sort of terminal, and the programs will generally only work with the terminal for which they were designed or with a device like the BBC Microcomputer which can 'pretend' to be the right sort of terminal. If you don't know which type of terminal you want, therefore, consult the experts on your 'host' system.

It is possible to switch back and forth between types of terminal during a session, either by returning to the main menu or, in some cases, by special keys. Your host computer can also send commands to Termulator to change the type of terminal. Details are in Appendix E.

Two terminals for which much mainframe software is designed are the ANSI (VT100) terminal (used with DEC computers and many others), and the Tektronix 4010 terminal used with many different machines for graphical input and output. Termulator provides emulations compatible with each of these (certain VT100 features are not included, but all those required for the DEC EDT program, for instance, are present).

The VT52 terminal is an earlier DEC terminal with fewer features than the VT100; again, it should be chosen when you are using a program specifically written for it.

The 'glass Teletype' or 'dumb terminal' is the least specialised emulation in the set. It has a minimum of special features and responses, and should be used with any system which does not require the other special terminal types. If, for instance, an ANSI terminal is used with a system which does not 'know about' the special ANSI features, odd effects can be produced when the terminal attempts to send various special ANSI sequences to the host.

The 'BBC' terminal would normally only be used when the host machine is running a program which is specifically designed for a BBC terminal. In this emulation, everything that the host sends to the emulator is passed straight to the BBC Microcomputer 'VDU' function; that is, the host program can drive the BBC monitor directly. This allows the host to generate the full range of BBC graphics, including colour, but requires a program which 'knows' how to generate all these codes. The ANSI and Tektronix terminal emulators can enter a 'BBC mode' which is similar to the BBC terminal.

The 'hard-copy' terminal option turns the BBC Microcomputer into just a keyboard for an attached printer; it switches off the screen altogether and passes everything it receives to the printer. This enables your host system to drive your printer directly, possibly using special features of the printer not available directly in normal terminal operations. It also allows you to use a printer that has a parallel interface but no serial interface as a peripheral for the host computer.

6 The SETUP process

Before you can establish communication with your host computer, Termulator needs to know various details of how you want or need to operate. For instance, it needs to know what line speed (baud rate) you are using on your computer link, and whether 'parity checks' are to be carried out on incoming data. In addition to these details which must be correctly supplied before the emulator will work, there are various other choices in the SETUP stage which are purely for the user's convenience. For example, you can choose to have an audible 'click' every time you type a character, or to have a 'bell' sound every time you type past character position 72, and so on. A full list of SETUP options is in Appendix A.

The SETUP options which you *must* set correctly before the emulator will work are:

- Transmission speed
- Receive speed
- Data, parity and stop bits

Consult the experts on your host machine if you are uncertain about any of these.

You may also, for particular applications or host machines, need to set:

- The character set (US or UK ASCII; the only difference is the hash or sharp character (#) which becomes a pound sign in UK ASCII).
- The New-Line feature
- Local echo
- Wraparound
- Escape to BBC graphics
- GIN terminator (4010 only)
- Screen dump type
- Automatic X-ON/X-OFF

The SETUP options which you can normally choose freely for your own convenience are:

- Video output (normal (white on black) or inverse (black on white))
- Keyboard auto repeat
- Interlace
- Cursor type
- Keyclick
- Margin bell

All SETUP options are described in more detail in Appendix A.

You can change most of these options during a session, if you wish, by using BREAK to re-enter the main menu and selecting SETUP. The ANSI emulation also allows the host system to change certain options, overriding what you have set. However, transmit and receive speeds, and the data/parity/stop bit option, must not be changed in mid-session.

7 How to use SETUP

When you select option 1 from the main menu, the system will display a table of the current SETUP options. For each SETUP feature, there is a 'default value' which will be used by the Termulator ROM when you first enter it after switching on; however, once you have chosen your SETUP options, they will remain in force even through a 'hard reset' (CTRL and BREAK), until the BBC Microcomputer is switched off. (However, note that pressing BREAK and W together will restore the standard default settings.)

If you have a standard set of SETUP options which you always want, you can arrange to save it on disc (or other filing system), to avoid having to set it again every time you switch on.

7.1 Changing SETUP features

Assuming that you do need to change a SETUP feature, first identify (from the displayed list) the key associated with this feature (letters A to X). The current setting for the feature is displayed; if you press the correct key once, the setting is changed to the next possible value, if twice to the following one, and so on, until the setting has cycled through all possible values and returned to its starting point. For some SETUP features, of course, there are only two values, off and on, so every time you press the key you reverse the setting. A full list of possible settings for each feature is given in Appendix A.

7.2 Saving and loading your standard SETUP

Apart from changing SETUP options as described above, various other actions may be taken when in SETUP. Two are concerned with storing away and recalling the values you have just set up, so that you need not retype them next time. If you type S, the current characteristics are saved in a file called SETUP, on whatever is your 'default filing system', eg disc. Saving SETUP characteristics on disc can avoid time and trouble. Next time you switch on, having entered SETUP, you can simply type R (for recall) to bring back all your previous settings (provided the disc on which you saved them is inserted in your 'default' disc drive).

It is possible to automate this process even further using the !BOOT facility of the BBC Microcomputer (see the *Disc Filing System User Guide*). Instructions to enter Termulator, select SETUP, restore your standard SETUP options, exit to the main menu and enter the desired emulation can all be placed in an

EXEC file using ***BUILD**. Then pressing **SHIFT BREAK** when you have switched on will obey all these instructions.

7.3 The answerback message

Another possibility in **SETUP** is to set up an ‘answerback message’. This is a string of any characters whatever, up to a limit of 20, which can be stored away for future use. In particular, certain hosts will start the session by sending to the terminal a special character called ‘ENQ’, and if the ANSI or VT52 emulation receives this character it will send in return your ‘answerback message’ – which might, for instance, be the user identifier by which you are known to the host system. You can also send the answerback message yourself at any time by pressing **SHIFT** and **f0** (see Appendix B).

The other terminal emulations do not respond to **ENQ**, but you can still send the message yourself if necessary.

An answerback message is set up by first pressing **W** in **SETUP**, then choosing any character which does not appear in your message and typing it. Then type your message, and finish with your chosen ‘delimiter’ character again. For instance

```
. FRED BLOGGS .
```

or

```
$HAL1$
```

Since the answerback message can include any character code including **DELETE**, the **DELETE** key cannot be used to correct errors when you are typing in the answerback message. If you make a mistake, type the delimiter to terminate the message, and start again by pressing **W**.

Similarly, all **CTRL** codes are accepted as part of the answerback message, including **CTRL M (CR)** which is useful if your ‘answerback’ needs to consist of more than one line.

7.4 Leaving the SETUP phase

The last option in **SETUP** is **Z**, which returns you to the main menu.

8 Using the terminal emulators: general

Having established all the required characteristics using `SETUP`, you are now ready to start communicating with your host machine. At this point, if you have not done so earlier, you need to link your BBC Microcomputer to the host, for instance by dialling the appropriate telephone number if necessary. If you have a modem or acoustic coupler with a `DUPLEX/HALF-DUPLEX` switch on it, it should normally be set to `DUPLEX` or `FULL DUPLEX`.

If at this point you have trouble establishing contact, try inserting the plug in the RS423 socket at the back of your machine the other way up; it is easy to insert it upside down. Details of the RS423 connections are in Appendix G.

You should now be connected up to your host, and should be able to initiate the 'logging-on' process or whatever is required to allow you to use the host system.

8.1 Duplex and character reflections

When you use a terminal to communicate with a host computer, it is usual to operate in 'full duplex' mode. This means that when you type a character, it is not displayed directly on your screen, but is sent to the host system. In most cases the host system then sends it straight back again (reflects it), and at this point it is displayed on your screen. This arrangement serves two purposes: first, the user can check that the character sent has been correctly received (and may try to send it again if not), and secondly there may be certain characters or sequences of characters which the host does *not* reflect, but treats in some special way. Typically these are 'control' characters (typed by pressing a key while holding down `CTRL`) or 'escape sequences' introduced by the `ESCAPE` character.

Different hosts will recognise and act on different sets of control characters and escape sequences, but many of them have standard meanings, defined in ASCII code tables or various other ANSI standards. If a host receives a control character or escape sequence which it does not recognise, it will normally reflect it back like any printable character. The effect on the terminal of receiving a particular control character or escape sequence (whether as a reflection or initiated by the host) depends on the type of terminal; details are in later chapters.

It is possible, if required by the host, to operate the terminal emulators in 'half-duplex' or 'simplex' mode, but in many cases this will lead to every character you type appearing twice on your screen, so if this happens check your 'duplex' switch. Full duplex is essential for file transfer.

8.2 Modes and screen display

All the emulations use the BBC Microcomputer Mode 0 (but with a 24 line display in the ANSI and VT52 emulations), except for the BBC terminal emulator which starts in Mode 7. Thus most emulations provide for a screen display of thirty-two 80-character lines; details of the exceptions are given later.

9 The keyboard and special keys

There are some features of the various terminal emulators which are common to all of them, and these are described here. Separate chapters then describe the particular features of each terminal type.

9.1 Printable characters

In all terminal emulations, the standard alphabetic, numeric and punctuation keys simply send the appropriate ASCII code to the host. Any host will normally then 'reflect' the character it has received and it will be displayed on the screen. Note that the 'pound' key sends ASCII back-apostrophe (grave accent), and that the 'hash' (sharp) key is displayed as hash or pound according to the choice of US or UK ASCII.

The printable characters, therefore, behave as one might expect. However, some of the other keys do have special effects which the user may need to know about.

9.2 The BREAK key

The first of these special keys is BREAK, which at any time will return you to the main menu, without interrupting your dialogue with the host. You can thus change SETUP options or switch to a different type of terminal, initiate a file transfer, etc, at any time. Note that if BREAK is pressed while CTRL or SHIFT is held down, its action is as for a normal BBC Microcomputer; that is, CTRL BREAK gives a 'hard reset' (exits from the Termulator and returns you to your default system), and SHIFT BREAK initiates your BOOT sequence if any (see the *Disc Filing System User Guide*).

On many terminals, the BREAK key causes a 'line-break' which (for many hosts) interrupts whatever your host is doing. On the Termulator, line-break is produced by SHIFT CTRL f9 (see below).

9.3 ESCAPE

The ESCAPE key, which in normal operation of the BBC Microcomputer is used to interrupt programs, should *not* normally be used within the Termulator program. This is because it sends the ESC code, used to start 'escape sequences' (see chapter 10), which are specially defined to control interaction between

terminal and host. If you press ESCAPE, it may be taken as the beginning of an escape sequence to perform some action you did not intend. If you press it by mistake, the effect will depend very much on your host, but you are likely to lose one or more subsequent characters in transmission one way or the other. Experienced users may of course wish to send escape sequences by this means, but most sequences in common use are provided more simply via the function keys (see below).

9.4 SHIFT and CAPS LOCK

The CAPS LOCK, SHIFT LOCK and SHIFT keys work exactly as for normal BBC Microcomputer use; that is, CAPS LOCK gives upper-case letters, but the lower character shown on all other keys, and SHIFT gives the upper character in all cases. See the *BBC Microcomputer System User Guide* for details. On entry to any terminal emulation within Termulator the keyboard is set to lower-case (CAPS LOCK and SHIFT LOCK both off). Note, however, that the 'caps lock' and 'shift lock' lights may be lit for reasons which have nothing to do with shift keys (see X-ON and X-OFF, below).

9.5 TAB, RETURN, DELETE and BACKSPACE

The TAB key sends a tab character. The effect of this depends on the host. If a tab is received, then in the ANSI and Tektronix emulations there are 'tab stops' at every eighth character. Received tabs are converted into the appropriate number of spaces for display on the screen. There are no user-settable tab stops.

The RETURN key normally sends Carriage Return (unless NEWLINE mode has been chosen in SETUP, in which case it sends Carriage Return and Line-Feed). Note that if you either find all your lines double-spaced or all your lines superimposed, you may need to change the NEWLINE option in SETUP. For similar problems on a printer, see chapter 16. Line-Feed alone is sent by CTRL J, see below.

The DELETE key sends a DELETE code and for most hosts this will have the expected effect of deleting the last character typed. There is no BACKSPACE key but CTRL H (see below) sends the backspace code.

9.6 Cursor and COPY keys

The cursor (arrow) and COPY keys can normally be used exactly as they are used on the BBC Microcomputer (see the *User Guide*). That is, a secondary cursor can be moved round the screen and the character above it is copied to the current input line when COPY is pressed. The cursor keys do not themselves send anything to the host. This is very useful when commands have to be repeated or when a long command has been typed with an error in it. For some

applications programs in the ANSI and VT52 emulations, the cursor and COPY keys are used for something else, and this feature is not then available (see chapter 10).

9.7 CTRL

The CTRL key, like SHIFT, does not of itself do anything, but if it is held down while another key is typed it produces 'control codes' which are used for special purposes. Again, most of these should not be used unless you understand their effects, which will normally depend on the host (for instance CTRL Z is used to signal the end of typed input on many DEC machines, but will not necessarily have the same meaning to other hosts). CTRL J sends the ASCII code for Line-Feed and CTRL H sends Backspace.

If you send a CTRL character to a host which does not have a special use for it, the most likely effect is that the host will simply 'reflect' the character; this may in turn have unexpected effects on your terminal.

CTRL characters which are used for various purposes when operating the BBC Microcomputer on its own may not work when the machine is operating as a terminal; they will be sent to the host which may or may not reflect them. If they are reflected then the terminal emulator may or may not recognise them (see Appendix C). For instance, CTRL B and CTRL C should not be used for switching the printer on and off; a function key is provided instead (CTRL SHIFT f3, see below).

The effects of various CTRL characters sent by the host to the terminal emulators are described in Appendix C.

9.8 CTRL Q and CTRL S (X-ON and X-OFF)

Two CTRL combinations which are frequently used are CTRL S and CTRL Q. These only work with a host which supports 'X-ON/X-OFF flow control' (ask the experts on your host system). Then if you hold down CTRL and type S, it will interrupt transmission from your host. This is very useful, for instance, if information is appearing on your screen faster than you can read it; you can hold up transmission until you are ready to carry on. When you are ready to restart, hold down CTRL and type Q.

There are various other conditions under which transmission from the host may be held up. Provided that 'AUTO X-ON/X-OFF' is ON in SETUP, then if information is arriving from the host too fast for Termulator to process it, the Termulator will automatically send the X-OFF (CTRL S) character to halt transmission. However, if the Termulator has done this, it will itself send X-ON again when appropriate, so you should not need to type CTRL Q. If the Termulator has sent an X-OFF character because its input buffers were full

(information arriving too fast to be processed), the 'caps lock' and 'shift lock' lights will come on.

Pressing CTRL and SHIFT together has the effect of halting output to your screen from the Termulator software. This in turn causes the 'screen buffer' to fill up, and the emulator to send X-OFF to the host. Releasing the keys will normally cancel the effect.

All these features only work with a host which supports X-ON/X-OFF, so for other hosts there is a danger that input may be lost if characters arrive too fast. (Other means of 'flow control' provided on some modems, for instance, may solve this problem, but they also depend on cooperation from the host system.) For this reason, file transfer will not normally work with a host without means of flow control, and at high receive speeds (2400 baud or more), or when operating a slow printer, flow control is vital. Whether flow control is available to you may depend on the line or network you are using to access the host as well as on the host itself (consult your local experts).

On hosts without flow control, some means of interrupting output is usually provided (sometimes it is 'line-break', CTRL SHIFT f9); consult the experts on your host system. Output interrupted in this way cannot normally be resumed.

9.9 Function keys

The remaining special keys on the BBC Microcomputer keyboard are the red function keys. These may be operated alone or in conjunction with SHIFT, CTRL or both SHIFT and CTRL, giving 40 possibilities in all. Many of these 40 operations generate special 'escape sequences' appropriate to particular host programs, for instance the DEC EDT Editor. In the ANSI and VT52 emulations, the function keys are used to provide the same escape sequences as those which can be generated by the numeric keypad on a VT100 or VT52 terminal.

9.10 CTRL function keys

If you have yourself set up the function keys to generate character strings (using the *KEY command, see the *BBC Microcomputer System User Guide*), then your settings will be transferred to the CTRL function key positions; that is, if you had set up a character string in f1 (using *KEY 1 <string>), then you can produce this string within the terminal emulator by typing CTRL f1.

9.11 Function and SHIFT function keys

Most of the ordinary function keys, and the SHIFT function key combinations, are used in the ANSI and VT52 emulations to generate escape sequences discussed later; the only one of these keys which applies to all emulations is SHIFT f0 which sends the 'answerback message'.

9.12 CTRL SHIFT function keys

The CTRL SHIFT function key combinations are used by most of the emulations, to switch from one terminal emulator to another, or to switch the printer, SPOOLing or file transmission on and off. Details are in Appendix B. The most commonly used of these is CTRL SHIFT f9, which sends a 'line-break' to the host (that is, it interrupts the carrier signal for 230 milliseconds). The effect of this varies with the host, but it is often used to interrupt output or processing, or to disconnect from a network. On other terminals this is often done by a BREAK key.

9.13 The function key cards

To help you to remember the uses of the function keys, two sets of three function key cards are provided with the Termulator. These are simply pieces of card which can be placed on top of the BBC Microcomputer above the function keys.

The function key cards for the ANSI and VT52 emulations show the way in which the function and SHIFT function keys correspond to the numeric keypad on a VT100 or VT52 terminal. If you are using a standard program such as the DEC EDT program which has special meanings for all these keys, you may find it useful to make your own function key card with this information. The standard card does not include the 'escape sequences' for ANSI and VT52, but these can be found in Appendix D.

10 The ANSI and VT52 emulations

These emulators are entered by selecting 2 or 3 from the main menu. You can switch between the two, and the Tektronix 4010 emulator, using CTRL SHIFT function keys (see Appendix B). Your host computer can also make these switches, and can also switch your terminal into and out of 'BBC mode', see chapter 13.

The ANSI emulation is designed to conform with ANSI Standards X3.4, X3.41 and X3.64, and to provide most of the features of a 'VT100' terminal. In particular, the red function keys and the SHIFT function key combinations are used to represent the 'numeric keypad' of a VT100 or VT52; details of the correspondence are in Appendix E. The correspondence to the numeric keypad, and the escape sequences transmitted, are different for the two emulations (as for the original VT100 terminal in VT52 or ANSI mode).

The numeric keypad of a VT100 or VT52 can either transmit ordinary numbers or, if set in 'application' mode can transmit certain ANSI-defined escape sequences. The corresponding keys in Termulator are always in 'application' mode, that is, they always transmit the escape sequences.

The cursor keys and the COPY key on the BBC Microcomputer, however, may change their function in an ANSI or VT52 emulation. As noted above, they normally work as on the BBC Microcomputer (so that of themselves the cursor keys do not transmit anything to the host). However, a special 'escape sequence' which the host can transmit to the emulator (the same as used to set a VT100 into applications mode) will change the effect of these keys. The cursor keys instead of moving the cursor directly now transmit to the host the escape sequences defined by ANSI for cursor movement. Normally, the host will respond by sending the emulator a command to move the cursor, so that it looks as if the keys have moved the cursor – but this time the host knows about it, which is important for editors and similar programs.

The user can also switch the cursor keys back and forth between their normal 'BBC' function and the 'applications' mode in which they transmit escape sequences. This is done using SHIFT f1, and may be useful, for instance, if the host software expects to receive the usual escape sequences but does not send the 'applications mode' sequence to request them.

When 'applications mode' is set, the COPY key transmits a BACKSPACE character.

The escape sequences transmitted by all these keys need only concern you if you are writing your own processing program on the host computer. For using standard software designed for a VT100 or VT52 terminal, you only need to know what this particular software does when you press a key; thus in the DEC editor EDT all the keys have special meanings which are described in the Editor manual.

Note that all the keys which transmit escape sequences are only useful if you know that your host, or the program running on it, will recognise the escape sequences and do what you intend with them. Otherwise, they will normally just be 'reflected' back to your terminal.

The host computer may also send a wide range of ANSI-defined escape sequences to your terminal; Termulator accepts most of those accepted by a VT100, plus a few 'private' sequences for special purposes (switching to Tektronix emulation or 'BBC mode'). A list is given in Appendix E.

Among the commands your host can send to your terminal by means of escape sequences are those to move the cursor, change certain SETUP characteristics, erase parts of the screen, change characters to double height or width, and change from ordinary character printing to 'special graphics' characters which allow simple pictures and graphs to be drawn.

The VT52 emulation recognises a much more limited set of escape sequences; see Appendix E for details.

The host can also send certain commands to the terminal by means of 'control codes' (single characters in the range ASCII 0-31). Those which the ANSI and VT52 emulations recognise are listed in Appendix C; any others from the standard ASCII set will be ignored. Because most hosts will reflect control characters for which they have no special use you can make the host send you some of these characters by typing them yourself, for instance CTRL G which causes a 'bell' sound.

In summary, you can use the ANSI or VT52 emulator:

- 1 Ignoring most of the function keys, etc, and simply using the keyboard to send printable characters (beware of the ESCAPE key). In this case you would probably do better to use the 'dumb terminal'.
- 2 With a standard host program written for a VT100 or VT52 terminal, in which case you need to know how the function keys correspond to a VT100 or VT52 keypad or just what they do for your particular program.

3 With your own programs written for the host, in which case you need to know what escape sequences are sent by which keys, and write your program to deal with them accordingly.

The principal VT100 features not included in Termulator are 132-column width, the 'smooth scroll' facility, and tab programming.

11 The Tektronix 4010 emulator

This emulator is normally used with host software specially designed for a Tektronix-compatible output device. On this terminal you can draw pictures to within the resolution of the BBC Microcomputer (but only in black and white), and you can also arrange to input a drawing which you make by moving special 'cross-hairs' round the screen using the cursor keys or a joystick. (All that you actually send the host is a series of coordinate pairs, one being sent every time you choose; it is up to the program on the host to turn these pairs into a picture or process them as required).

In this emulation you can also ask for a 'screen dump' to a suitable printer (Epson-compatible). A screen dump can be initiated by the host, or by pressing CTRL SHIFT f1. The screen dump takes about 3 minutes and is scaled to 8 inches by 6.4 inches.

The 4010 emulator has four 'modes' of operation:

- scrolling alpha (for ordinary text transmission and reception)
- graphic plot (for drawing pictures sent by the host)
- graphic alpha (for text alongside pictures)
- graphic input (for sending coordinates to the host).

Switching between these modes will normally be under the control of the host program.

The function and SHIFT function keys have no role (except SHIFT f0 which sends the answerback message). The CTRL SHIFT function key combinations are used to switch to other emulations, etc, (see Appendix B) and for specific 4010 functions; CTRL SHIFT f0 clears the screen, CTRL SHIFT f1 starts a screen dump, and CTRL SHIFT f2 restores 'scrolling alpha mode'. For more details of standard Tektronix 4010 use, see the Tektronix 4010 User's Guide.

The emulator recognises a small number of escape sequences and control codes (see Appendices C and E); again, these need not concern the user who is working with a standard host program designed for this terminal.

Note that the normal 4010 coordinates (ie those which host programs will expect to receive and transmit) are on a 1024 by 1024 grid. A Tektronix 4010 only displays Y-coordinates up to 779; the Termulator version displays up to 819. All received coordinates are scaled up to 1280 by 1280, to fit the BBC

Microcomputer, and plotted in Mode 0. For graphics input the 'BBC' coordinates are correspondingly scaled down before transmission, and after scaling the Y-coordinate must be less than 779 for compatibility with the Tektronix software.

When the emulator is in graphics input (GIN) mode – which is normally caused by receiving the appropriate escape sequence from the host – it will display 'cross-hairs' which you can move using the arrow keys. If the SHIFT key is held down while the arrow keys are typed, each step will be larger (10 pixels instead of 1). The COPY key puts the cross-hairs at the centre of the screen. When the cross-hairs are at the position whose coordinates you require to send to the host, press any printable key, eg a letter or number, and the emulator will send to the host the cross-hair position, preceded by the character typed. To operate in GIN mode you must set the GIN terminator in SETUP to whatever is required by the host system (consult local experts).

If you have a joystick on your BBC Microcomputer, you can use the joystick to move the cross-hairs and the FIRE button to send their position. The GIN terminator setting also indicates to Termulator whether it is to accept signals from a joystick by adding a 'J' prefix.

For users writing their own host programs, the coordinate system and various transmission sequences are described in Appendix F.

From within the Tektronix emulation, it is possible (under the control of the host only) to switch to 'BBC mode'. In this condition all received codes are passed straight to the BBC VDU driver and interpreted as in normal BBC Microcomputer operation (see the *BBC Microcomputer System User Guide*). On return to the Tektronix emulation, screen modes, colours etc are *not* reset to their standard values. It is, therefore, possible, given a suitable host program, to switch back and forth in such a way as to produce, for instance, multi-coloured Tektronix-style pictures. See chapter 13 for more details of this feature.

12 The ‘dumb terminal’ emulator

This emulator should be used with any host which does not specifically cater for ANSI or Tektronix terminals. It is the simplest of the set, and does not handle escape sequences at all (ESC is ignored).

All printable characters behave as normal. A small set of control codes is recognised (mainly for cursor movement). See Appendix C for details.

The function keys and SHIFTeD function keys are not used (except SHIFT f0 which transmits the answerback message). CTRL function keys transmit character strings set up by *KEY, as usual. The only CTRL SHIFT function keys which are significant are line-break (CTRL SHIFT f9) and those for switching the printer and spool files (see Appendix B).

Once in this emulator, you can only switch to other terminal emulations by using BREAK to get back to the main menu.

13 The BBC terminal emulator and BBC mode

These are used specifically for obtaining 'BBC' graphics, including colour. They depend entirely on having a program running on the host computer which generates suitable codes to be sent directly to the BBC VDU driver; all codes received are treated in this way.

The BBC terminal emulator is entered only from the main menu, and left only by recalling the main menu. 'BBC mode' within the ANSI or Tektronix emulation is switched on and off again only by the host. Once in either the BBC terminal or BBC mode, all received codes are sent to the BBC VDU driver; the only escape sequence recognised is, for BBC mode, the one which switches back to the original terminal type.

At SETUP time, there is an option to disable the particular escape sequence which switches from ANSI or Tektronix terminals into BBC mode. See Appendix A.

By default the display for the 'independent' BBC terminal emulator is Mode 7, but the mode can be changed by suitable VDU codes (see the *BBC Microcomputer System User Guide* for these and for all BBC graphics).

Teletext mode is only possible if the data transmission format (see SETUP) is 8 bits. In addition, host systems using 7-bit data transmission may be restricted in the use of certain VDU codes (those which require 8-bit data to follow them, such as VDU 1, 17, 18, 23, 24, 25 or 29). This difficulty can be avoided in some cases if the device drivers on the host can be programmed to force 8-bit transmission on occasion; this is a matter for experts on the host system.

Within the BBC terminal emulator or in BBC mode, the same function keys are used as for the 'dumb terminal'. Received control codes or escape sequences are not recognised (with the one exception above) since everything is sent to the VDU driver. Control characters which are valid for the VDU driver (see the *BBC Microcomputer System User Guide*) may be sent.

Note that returning from BBC graphics mode to Tektronix emulation does not clear the screen or reset the mode (whereas returning to ANSI does both). By switching back and forth it is possible, for instance, to draw multi-coloured pictures using Tektronix graphics. For example, if the host sends the following sequence (shown here in hexadecimal):

1B5B2A76 (ESC [* v which is escape to BBC graphics)
1601 (SYN SOH select screen mode 1)
120001 (DC2 NUL SOH set graphics foreground to red)
1B5B2576 (ESC [% v return to Tektronix)

followed by some standard Tektronix graphics, and then a similar sequence setting graphics colour to yellow, and some more graphics, the yellow picture will be superimposed on the red one.

BBC mode is also useful occasionally for switching on the printer under host control. This is done by the host sending

1B5B2A76021B5B2576 (ESC [* v STX ESC [% v)

To turn the printer off again send the same sequence substituting 03 (ETX) for 02 (STX).

14 The hardcopy terminal

In this mode, all received codes are sent directly to the parallel printer port, and nothing goes to the screen; in effect, the terminal becomes just a keyboard and printer for the duration. It is usually convenient to use some other emulation for logging on to the host and initiating a suitable program. The advantage of this mode is that because everything is sent to the printer, special control sequences for the particular printer may be sent by the host without being intercepted by the screen-driving routines; all special features of the printer can therefore be used. This feature of Termulator also removes the need to buy a special keyboard or a serial interface for an existing parallel-interface printer.

The printer must be 'online' when this terminal emulator is entered.

The only way to get out of this emulation is to use BREAK and the main menu.

The same function keys apply as for the dumb terminal, with the exception of CTRL SHIFT f3 to switch the printer, which does not apply.

15 File transfer

This can be used, for instance, to send the contents of a file you have stored on a BBC disc to your host, or vice versa. It is only designed for ASCII text files (not, for instance, for stored BASIC programs on the BBC Microcomputer, which are in a special format), and it requires the host to support X-ON/X-OFF. You also need to be operating in 'full duplex' mode (see chapter 8).

Files may only contain ASCII printable characters and tab. BBC files to be transmitted should be in 'character' not 'string' format, ie generated by *SPOOL or *BUILD but not by PRINT#, and should have lines separated by a carriage return.

To send a file to the host, the emulator takes the file from your disc and treats it as if you had just typed it in at the keyboard. Similarly, files received from the host are sent to the VDU as if they were normal output, but the SPOOL facility is switched on so that the file is recorded on disc as well.

You may wish to strip line-feed characters from files as you send them to the host to prevent double line spacing. Before transmission starts you will be asked whether you want to do this; a preliminary experiment will show whether it is necessary. If line-feeds are stripped, so also are all CTRL characters *except* backspace (BS, CTRL H), HT (horizontal tab, CTRL I), VT (vertical tab, CTRL J), FF (form feed or clear screen, CTRL L) and CR (carriage return, CTRL M).

If you select the 'file-transfer' option from the main menu, you will be asked for the name of the BBC file which is to be sent or into which the received file is to be put, and whether you want to transmit or receive. The Termulator then enters the 'dumb terminal' emulation to allow you to log on if necessary and to send a suitable command to your host (to tell it to send you the contents of a file, or to announce that you are about to input a file). Then you type CTRL SHIFT f7 to initiate the transfer. The contents of the file will appear on your screen as it is received or, for transmitted files, on reflection by the host.

At the end of the transmission, type CTRL SHIFT f8 to close the BBC file. If you are sending a file to your host, you will probably also need to terminate that in whatever way is normal for the host.

Function keys are as for the dumb terminal, but you should normally avoid typing anything during the transmission, unless you want to abandon the transmission altogether (line-break, CTRL SHIFT f9, will normally achieve this, but you may need CTRL SHIFT f8 to close the BBC file as well).

16 Using a printer

If you have a parallel-interface printer, you can use it in several ways to enhance the facilities of your terminal.

Firstly, you can arrange to have a 'hard copy' record of your terminal session, which simply reproduces all printable characters appearing on your screen. At any stage in your session, you can turn the printer on using CTRL SHIFT f3; pressing the same key again turns the printer off again. Note that CTRL B and CTRL C which are used to switch the printer on and off in normal BBC Microcomputer operation are not recommended; like all other control characters they will be sent to the host which may or may not reflect them, and even if reflected they will only take effect in the BBC terminal emulation.

This method is suitable for recording any straightforward 'text' session, but will produce unpredictable effects if you are using your screen to draw pictures, or using the 'special graphics' characters of the ANSI mode.

If you find that all the lines on your printer are being superimposed, you need to cancel the 'ignore line-feeds' instruction which is set by default in the BBC system. Return to the main menu using BREAK, and issue the Operating System command

```
*FX 6,0
```

If, after this, you then find that your screen dumps are coming out double-spaced, you may need to adjust the automatic line-feed option on your printer. The only reliable way of getting both text printing and screen dumps right is to have *FX 6,0 set (as above) and to have the automatic line-feed option of your printer switched off. If you only want text printing, then the reverse combination (default *FX6 setting and line-feed option on) will also work.

16.1 Hardcopy mode

This is similar to the simple record of the session described above except that there is no option for turning the printer on and off. However, because the received codes are sent straight to the printer, you can arrange to use any special facilities your printer may have, by programming your host to send suitable control sequences direct to the printer. In this way you can make use of highlighting features, microspacing, page layout and even graphics, limited only by what your printer can do. To make full use of these features you need to

write, or have available, a program on the host which is designed to drive your particular model of printer.

The BBC terminal emulator can also be made to drive a printer with full facilities, by sending suitable VDU codes, but the hardcopy terminal will usually be simpler to use.

16.2 Screen dumps

As an alternative to continuous recording of your session, you can arrange to set up a particular screenful of text or pictures, and then reproduce the whole screen on your printer. This is normally done only within the Tektronix emulator.

To use the screen dump facility you need the right sort of printer (Epson-compatible). The picture is of a fixed size (8 inches by 6.4 inches) and takes about 3 minutes to draw. Within the Tektronix emulation, CTRL SHIFT f1 calls for a screen dump. If you press ESCAPE during the dump, the dump is abandoned.

It is possible to write your own screen dump routine (for a different printer, for instance) which is then called in the same way as the normal one. Such a routine, written in 6502 Assembler for the BBC Microcomputer, should be placed in memory locations `&2800` up to `&2DFF`, by `*LOADING` it from the main menu. The entry address of the code should be `&2800` and exit should be effected with an `RTS` instruction. To use this routine, the 'Screen Dump Type' in `SETUP` needs to be set to 'SPECIAL'.

16.3 *SCDUMP

It is also possible to invoke the normal screen dump routine directly using the Operating System command `*SCDUMP`. This could be done from the main menu but would of course only result in a printer copy of the main menu display. It is designed for use outside the Termulator system altogether, if you have produced a picture or text on your screen by some other means (a BASIC program for instance) and require a printer copy of it.

The `*SCDUMP` command can also be used with a filename. The file should contain a `SP00L`ed display or picture from an earlier session (see below), and the Termulator will `REPLAY` the session before starting the screen dump. In this way, a picture drawn with ANSI graphics or with BBC graphics can be reproduced (in black and white only).

17 Spool and replay

The BBC Microcomputer provides a Disc Filing System command, ***SP00L**, which allows you to send to a file on disc everything appearing on your screen. You can issue this command from the main menu, the format being

```
*SP00L filename
```

However, spooling does not start at once, so that the menu does not appear in the spooled file. To commence spooling to your named file, you must also press CTRL SHIFT f7. Pressing this key again will turn spooling off but leave the file open for further spooling; to close the file when you have finished, use CTRL SHIFT f8.

You can spool sessions, or parts of sessions, which include Tektronix or BBC graphics (including colour). A spooled session can be replayed using the ***REPLAY** command. There is no need to enter the Termulator for this; simply type

```
*REPLAY filename
```

You do, however, need to set your BBC Microcomputer to the correct mode before replaying a session (for an ANSI or Tektronix session type MODE 0, for BBC graphics set whatever mode was in use when spooling was switched on).

To replay a session and then send the final screen display to a printer, use the ***SCDUMP** command described above.

Appendix A

Terminal SETUP

The following options may be set in SETUP using the letter specified; some may also be changed later in the session by escape sequences received from the host computer, and most can be changed by the user re-entering SETUP from the main menu. Line speeds and data/parity/stop bits may not be changed during a session.

If W and BREAK are typed together, the 'power-on' default characteristics listed below are restored. Otherwise the SETUP characteristics remain set until they are changed (by the user or the host) or the BBC Microcomputer is switched off.

A (transmit speed) and B (receive speed)

Possible values are 75, 150, 300, 1200, 2400, 4800 (default) and 9600 baud. The values are determined by the equipment in use (some modems and acoustic couplers are switchable, but the type of line will set an upper limit). For receive speeds of 2400 baud or more, it is essential that the host system recognise X-ON/X-OFF.

C Video output (not applicable to BBC or hardcopy terminals)

Options are NRML (normal, white on black) and INV (inverse, black on white). This option can be changed by the host in the ANSI emulation.

D Character set (ANSI and VT52 emulations only)

This is US ASCII (characters as keyboard except pound key which transmits 'back apostrophe') or UK ASCII (as US except 'hash' (SHIFT 3) is displayed as pound sign). The default is US. This option can be changed by the host in the ANSI emulation.

E Data, parity and stop bits

The required values for these depend on the host, and they must be correctly set for communication to take place. 'Data' is 7 or 8 (number of bits per character); 'parity' is E (even) or O (odd) or N (not present), and 'stop bits' are 1 or 2. The whole group cycles through the values in the order

7E2, 7O2, 7E1, 7O1, 8N2, 8N1 (default), 8E1, 8O1.

F Newline (not applicable to BBC terminal)

Newline can be OFF (default) or ON. When it is on, pressing RETURN causes the two characters (carriage return, line feed) to be sent to the host, and a line feed received from the host is interpreted as carriage return then line feed. Whether this is appropriate depends entirely on the host; if no line feeds, or double line feeds, occur consistently then the Newline feature probably needs to be turned on or off respectively.

This option can be switched by the host in the ANSI emulation.

G Local Echo

This can be OFF (default) or ON. If it is on, all characters typed are echoed to the screen as well as being sent to the host. This will usually result in all typed characters appearing twice; local echo should only be set to ON if the host does *not* reflect received characters.

H Wraparound (not applicable to BBC or hardcopy terminals)

This feature is also OFF (default) or ON, and it determines what happens when you type beyond the 80th character position (the right hand side of the screen). If wraparound is OFF, further characters just overwrite the 80th character position (though they will be sent to the host as usual). If it is ON, characters beyond the 80th appear on the following line. If lines of more than 80 characters are received from the host, they are treated in the same way. This feature can be switched by the host in the ANSI emulation. In the 'dumb terminal' emulation wraparound occurs at character position 79 rather than 80.

I Screen Dump type (Tektronix 4010 only)

This is NORM (normal Epson) or SPEC (special user-written screen dump). See chapter 16 for details.

J Escape to BBC graphics (ANSI and 4010 terminals only)

This is ON (default) or OFF. If it is on, the host is allowed to switch Termulator to 'BBC mode' by sending the appropriate escape sequence. If the option is off, the escape sequence is ignored.

The reason for having this facility is that the escape combination in question is a 'private' one, as allowed by the ANSI standard, but there might be software running on a host which issued this escape sequence for some other purpose.

K Auto Repeat

This is ON (default) or OFF. If it is on, a key which is held down will 'repeat' as in normal BBC Microcomputer operation. It affects practically all keys (unlike a VT100 where RETURN, TAB and CTRL combinations are exempt). This feature can be switched by the host in the ANSI emulation.

L GIN terminator (Tektronix 4010 only)

This fixes the terminator which the terminal will send to the host after transmitting the cross-hair coordinates for graphics input. This may need to match the particular requirements of the host system (consult local experts). It also needs to be set if you are using a joystick to move the crosshairs. The options correspond to those which can be set as 'strappable options' on a 4010 terminal. The choice is

NO (no terminator)

CR (carriage return; default)

CT (carriage return followed by EOT (ASCII 04))

or the same three preceded by J if the joystick is active. The 'J' simply tells the Termulator to accept input from the analogue port; it does not affect what is sent to the host.

M Interlace (not applicable to hardcopy terminal)

This is OFF (default) or ON; depending on your monitor, screen flicker may be improved by changing the setting.

N Cursor type (not applicable to BBC or hardcopy terminal)

The cursor which indicates the current character position can be an underline or a solid block, and flashing or stationary. The choice is

F UL (flashing underline), F BK (flashing block: default),

S UL (static underline) or S BK (static block)

O Keyclick sound

This is OFF (default) or ON, and is purely for user convenience. If it is on, an audible click accompanies each key depression.

P Margin Bell (not applicable to BBC or hardcopy terminal)

This is OFF (default) or ON; if it is on, a bell sounds when character position 72 is reached (provided at least one character has been typed on the line).

R Restore terminal characteristics from saved file

See chapter 7 for details.

S Save terminal characteristics

See chapter 7 for details.

W Answerback message

See chapter 7 for details. The message is defined in SETUP by typing W then:

```
terminator message terminator
```

where the terminator is any single character and the message is up to 20 characters not including the terminator. The default is 'TERMULATOR'. The terminal will send the answerback message in response to an ENQ character from the host in the ANSI or VT52 emulations. All the terminals allow the user to send the message by pressing SHIFT f0.

X Automatic X-ON/X-OFF

This is ON (default) or OFF. If it is on, the terminal will send an X-OFF (interrupt transmission) code whenever the input buffer fills up (because data is arriving too fast to process, or because CTRL and SHIFT are being held down). If the option is off, X-OFF is not sent.

If the option is ON, then the emulator sends X-ON automatically when the input buffer clears. Occasionally (if X-OFF characters have been sent both by the user and automatically by Termulator), CTRL Q may be needed to restart transmission.

Flow control is also discussed in chapter 7.

Appendix B

Function keys

B.1 CTRL function keys

In all emulations, CTRL function keys are used to contain any character strings set by the user using the *KEY commands.

B.2 Function keys and SHIFT function keys

In the ANSI and VT52 emulations, all these except SHIFT f0 and SHIFT f1 are used to send escape sequences as provided by the VT100 and VT52 keypads. See Appendix D for details. SHIFT f1 switches the operation of the 'cursor keys', see chapter 9.

The other emulations do not use this set of keys at all, except SHIFT f0.

In all emulations, SHIFT f0 transmits the answerback message.

B.3 SHIFT CTRL function keys

These are used as follows:

Key	Effect	ANSI VT52	4010	dumb BBC	hard copy	file transfer
CTRL SHIFT f0	screen dump	no	yes	no	no	no
CTRL SHIFT f1	clear (gr.) screen	no	yes	no	no	no
CTRL SHIFT f2	scrolling alpha	no	yes	no	no	no
CTRL SHIFT f3	printer on/off	yes	yes	yes	no	no
CTRL SHIFT f4	enter ANSI	yes	yes	no	no	no
CTRL SHIFT f5	enter VT52	yes	yes	no	no	no
CTRL SHIFT f6	enter 4010 (or restart)	yes	yes	no	no	no
CTRL SHIFT f7	spooling on/off or open BBC file	yes —	yes —	yes —	yes —	— yes
CTRL SHIFT f8	close spool file or close BBC file	yes —	yes —	yes —	yes —	— yes
CTRL SHIFT f9	send line-break	yes	yes	yes	yes	yes

Appendix C

Control codes recognised by the emulators

The BBC and hardcopy terminal emulations pass all received codes including CTRL codes straight to the VDU driver or printer respectively, and their effects are as for the BBC VDU driver (see the *BBC Microcomputer System User Guide*) or the printer. During file transfer no received control codes are recognised. The other emulations recognise control codes as follows:

Character	hex	name	effect	ANSI VT52	4010	dumb terminal
CTRL E	&05	ENQ	transmit answerback	yes	no	no
CTRL G	&07	BEL	bell	yes	yes	yes
CTRL H	&08	BS	backspace	yes	yes	yes
CTRL I	&09	HT	tabs every 8 chars or cursor forward 1	yes	yes(scr) yes(Tek)	– yes
CTRL J	&0A	LF	line feed (CR LF if NEWLINE)	yes	yes	yes
CTRL K	&0B	VT	as LF or cursor up	yes	– yes	– yes
CTRL L	&0C	FF	as LF or clear text screen	yes	– yes	– yes
CTRL M	&0D	CR	carriage return	yes	yes	yes
CTRL N	&0E	SO	select G1 char set	yes	no	no
CTRL O	&0F	SI	select G0 char set	yes	no	no
CTRL X	&18	CAN	cancel current control sequence or restore scrolling alpha mode	yes	no yes	no –
CTRL Z	&1A	SUB	as CAN	yes	no	no
CTRL [&1B	ESC	start ctrl seq	yes	yes	no
CTRL \	&1C	FS	set point mode (*)	no	yes	no
CTRL]	&1D	GS	graphics mode	no	yes	no
CTRL ^	&1E	RS	incremental plotter mode (*)	no	yes	no
CTRL _	&1F	US	set gr.alpha mode	no	yes	no
DELETE	&7F	DEL	ignored	yes	yes	yes

(*) Point mode and incremental plotter mode are Tektronix 4014 features. Incremental plotter mode is effectively ignored by a 4010 and by Termulator, but point mode is implemented and is similar to PLOT 69 (see the *BBC Microcomputer System User Guide*), in that only a point at the end of the vector is plotted.

Appendix D

Escape sequences sent by ANSI and VT52 emulators

The use made of these escape sequences by the host depends entirely on the software at the host end. The DEC EDT program, for instance, uses these sequences for various editing functions.

Key	ANSI sends	Corresponding VT100 keypad key	VT52 sends	Corresponding VT52 keypad key
f0	ESC O P	PF1	ESC P	PF1
f1	ESC O Q	PF2	ESC Q	PF2
f2	ESC O t	4	ESC ? t	4
f3	ESC O u	5	ESC ? u	5
f4	ESC O w	7	ESC ? w	7
f5	ESC O q	1	ESC ? q	1
f6	ESC O R	PF3	ESC ? x	8
f7	ESC O r	2	ESC ? r	2
f8	ESC O p	0	ESC ? p	0
f9	ESC O n	.	ESC ? n	.
S/f0	answerback	HERE IS	answerback	HERE IS
S/f1	switch use of cursor keys	—	—	
S/f2	ESC O x	8	ESC S	PF4
S/f3	ESC O y	9	ESC ? l	,
S/f4	ESC O s	3	ESC ? m	—
S/f5	ESC O v	6	ESC ? s	3
S/f6	ESC O l	,	ESC ? v	6
S/f7	ESC O m	—	ESC ? y	9
S/f8	ESC O S	PF4	ESC R	PF3
S/f9	ESC O M	ENTER	ESC ? M	ENTER

Cursors and COPY

(in application mode only)

←	ESC [D	←	ESC D	←
→	ESC [C	→	ESC C	→
↓	ESC [B	↓	ESC B	↓
↑	ESC [A	↑	ESC A	↑
COPY	BACKSPACE		BACKSPACE	

Appendix E

Escape sequences recognised by the emulators

In addition to responding to certain received control codes (Appendix C), some terminals respond to received 'escape sequences' starting with the ESC character.

The 'dumb terminal', BBC and hardcopy terminals do not recognise any received escape sequences. Details of escape sequences recognised by the other emulations are given below.

E.1 Escape sequences recognised by the ANSI emulation

Most of these sequences are defined in the ANSI standard and have the effects specified there. Some (with names starting DEC) are 'private sequences' defined by DEC for use with the VT100 terminal. A few are 'private sequences' defined for the Termulator system.

There are normally no space characters in the sequences; those below are included for clarity.

In the list below, P_n denotes a (decimal) number; if it is omitted the given default is used

P_l is a line number (P_t =top, P_b =bottom)

P_c is a column number

P_s is a character chosen from a given list

Sequence	Name	Purpose	
ESC [P_n A	CUU	cursor up P_n lines	default $P_n=1$
ESC [P_n B	CUD	cursor down P_n lines	default $P_n=1$
ESC [P_n C	CUF	cursor right P_n steps	default $P_n=1$
ESC [P_n D	CUB	cursor left P_n steps	default $P_n=1$
ESC [P_l ; P_c H	CUP	cursor to position	default: cursor home
ESC [P_l ; P_c f		cursor to position	
ESC D	IND	cursor down with scrolling if needed (Index)	
ESC M	RI	cursor up with reverse scrolling (Reverse Index)	
ESC E	NEL	cursor to beginning of next line	
ESC 7	DECSC	Save cursor and attributes	
ESC 8	DECRC	restore cursor and attributes	

ESC [P _s ;	P _s ..m	SGR	select character attributes
	P _s =0		attributes off
	P _s =4		underscore on
	P _s =7		inverse video
ESC [P _n K		EL	erase in line (default P _n =0)
	P _n =0		erase cursor to end of line
	P _n =1		erase beg. of line to cursor
	P _n =2		erase whole of line
ESC [P _n J		ED	erase in display (default P _n =0)
	P _n =0		erase cursor to end of screen
	P _n =1		erase beginning of screen to cursor
	P _n =2		erase whole screen
ESC (A		SCS	set G0 characters to UK ASCII (changes SETUP)
ESC) A		SCS	set G1 characters to UK ASCII (note 1)
ESC (B		SCS	set G0 characters to US ASCII (changes SETUP)
ESC) B		SCS	set G1 characters to US ASCII
ESC (0		SCS	set G0 characters to special graphics (note 2)
ESC) 0		SCS	set G1 characters to special graphics
ESC # 3		DECDHL	set double height (top half) rest of line
ESC # 4		DECDHL	set double height (bottom half) rest of line
ESC # 5		DECSWL	set single width single height rest of line
ESC # 6		DECDWL	set double width rest of line
ESC [P _t ;	P _b r	DECSTBM	set scrolling region
ESC [20 h		LNM	set newline mode (changes SETUP)
ESC [20 l		RLNM	reset to line feed (no newline)
ESC [? P _n h		SM	sets modes as follows:
		DECCOLM	P _n =3 clear screen and home cursor (note 3)
		DECSCNM	P _n =5 set inverse video (changes SETUP)
		DECOM	P _n =6 set origin to top of scroll region
		DECAWM	P _n =7 set wraparound on (changes SETUP)
		DECARM	P _n =8 set auto repeat on (changes SETUP)
ESC [? P _n l		RM	cancel settings as above (except 2 which gives DECANM – enter VT52)
ESC =		DECKPAM	set application mode (cursor keys & COPY)
ESC >		DECKPNM	unset application mode (keys as BBC micro)
ESC [6 n		DSR	request cursor position
			to be sent to host using ESC [P _i ;P _c R
ESC [5 n		DSR	request status: always send ESC [0 n
ESC [0 c		DA	request device attributes: send ESC [? 1;0 c
ESC [* t	private		enter '4010' emulation
ESC [* v	private		enter BBC mode
ESC [% v	private		re-enter ANSI mode from BBC mode

Note 1: the G0 character set is used in ‘Shift in’ condition (default), and G1 is used in ‘Shift out’ (controlled by host sending SO or SI, see Appendix C).

Note 2: the ‘special graphics’ are as defined for a VT100.

Note 3: 132-character width is not supported but the standard escape sequence for setting 132-character width is accepted, and clears the screen and homes the cursor. Resetting it (ESC [? 3 l) does the same.

E.2 Escape sequences recognised by the VT52 emulation

ESC A	cursor up
ESC B	cursor down
ESC C	cursor right
ESC D	cursor left
ESC F	select special graphics character set
ESC G	select ASCII character set
ESC H	cursor to home position
ESC I	reverse line feed
ESC J	erase cursor to end of screen
ESC K	erase cursor to end of line
ESC Y l c	cursor to position (l and c are line & column numbers as character whose ASCII value is 31+line or column number (numbering from 1,1 top LH)
ESC Z	identify terminal: reply ESC / Z
ESC <	enter ANSI emulation

The private sequences are not available in VT52 mode.

E.3 Escape sequences recognised by the Tektronix 4010 emulation

ESC ENQ	return status, data and position bits (see Appendix F)
ESC ETB	start screen dump
ESC SUB	start cross-hair cursor
ESC FF	erase graphics screen, enter scrolling alpha mode and home text cursor
ESC [% t	(private) enter ANSI emulation
ESC [* v	(private) enter BBC graphics emulation
ESC [% v	(private) re-enter Tektronix 4010 from BBC mode

Appendix F

Further details of Tektronix 4010 emulation

Details of control characters and escape sequences recognised by the 4010 emulation are in Appendices C and E. This emulation does not send any escape sequences. It obeys almost the complete set of Tektronix 4010 codes and all Tektronix 4006 codes. Margins 0 and 1 (double column text) is not available.

A Tektronix terminal has four modes of operation: scrolling alpha (for text), graphics (for output of drawings), graphics alpha (for text alongside drawings, non-scrolling) and graphics input (for sending coordinate pairs to the host).

Initially, the terminal is in alphanumeric mode and output is 'scrolled' (moved up the screen to make room for more) as on a normal VDU terminal. The display is 32 lines of 80 characters. If graphics mode is then used, subsequent alphanumeric output is limited to 71-character width and there is no scrolling (when the screen is full, it starts again at the top).

Switching between modes is usually under the control of the host; however, using SHIFT CTRL function keys the user can initiate a screen dump, clear the entire screen or the graphics screen or restore 'scrolling alpha' mode. Recognised escape sequences and control codes provide for the host to switch to graphics alpha mode, scrolling alpha mode, graphics (line) mode and graphics input mode. There is also provision for switching to 'BBC mode' so that BBC graphics can be used, including colour.

The screen dump (which can be switched on by the user or by the host) is described in chapter 16.

Software designed for the Tektronix works with coordinates in the range 0 to 1023 in X and Y directions. In the emulator these are both scaled to 1279 and plotted in Mode 0. On a Tektronix the maximum Y-value actually displayed is 779; the emulator can display Y-coordinates up to 819.

F.1 Transmission of coordinates (host to terminal)

This operates exactly as for a Tektronix 4010. There is no need to know the details of this transmission unless you intend to write your own graphics programs on your host machine.

To transmit a coordinate pair, of which each may be in the range 0 to 1023, 20 bits of information have to be transmitted. These are sent in a 4-byte sequence

(1 byte = 8 bits), each byte containing 5 of the data bits, two 'tag bits' (identifying the byte), and a parity bit. The layout is as follows:

byte number	data bits	bit 7	6	5	4	3	2	1	0
1	first 5 of Y	P	0	1	D	D	D	D	D
2	last 5 of Y	P	1	1	D	D	D	D	D
3	first 5 of X	P	0	1	D	D	D	D	D
4	last 5 of X	P	1	0	D	D	D	D	D

If a group of 5 bits does not change between one coordinate pair and the next, the appropriate byte may be omitted provided that byte 4 must always be sent, and byte 2 must be sent if byte 3 is.

The host switches on graphics (line) mode by transmitting a GS code (hexadecimal 1D), and movement to the first coordinate pair takes place without a line being drawn ('dark vector'). For every subsequent pair received a line is drawn from the current to the new position ('light vector'). If further dark vectors are required they should each be preceded by a GS code. Point mode is switched on by FS (hex 1C) and causes a single point at the end of the received vector to be plotted.

F.2 Response to ESC ENQ received

The sequence ESC ENQ is sent by the host to request the current coordinates of the graphics text cursor. To prevent spurious plotting due to reflection by the host of this information, plotting is switched off (BYPASS mode) while the information is being sent. It is switched on again when any of the following are received:

BEL, CR, ESC ETB, ESC FF, LF, US, SI, CAN, dark or light vector.

The information sent to the host consists of a status byte (which cannot be varied), the cursor coordinates, and the current GIN terminator if any (as selected in SETUP). The layout is as follows:

byte number	data bits	bit 7	6	5	4	3	2	1	0
1	status	1	0	1	0	0	0	1	0
2	first 5 of X	1	0	1	D	D	D	D	D
3	last 5 of X	1	0	1	D	D	D	D	D
4	first 5 of Y	1	0	1	D	D	D	D	D
5	last 5 of Y	1	0	1	D	D	D	D	D
6 (optional)	CR	1	0	0	0	1	1	0	1
7 (optional)	EOT	1	0	0	0	0	1	0	0

The status bits are fixed, and have the standard significance they would have in a 4010, that is: hardcopy working (bit 4), linear interpolation off (bit 3),

graphics mode on (bit 2), at margin 1 (bit 1), no auxiliary device (bit 0). Note that the two-column mode of the Tektronix (Margins 0 and 1) is not supported.

F.3 Graphics input mode

When this mode is entered (when ESC SUB is received from the host), cross-hairs are displayed which can be moved by the cursor (arrow) keys; pressing SHIFT at the same time increases the step size. The COPY key centres the cross-hairs on the screen. A joystick can also be used, if available. The graphics input terminator (GIN terminator) must be set in SETUP to suit the requirements of the host system, and if a joystick is to be used this must also be set in the GIN option (see Appendix A).

When the required position has been reached, the fire button on the joystick, or any printable character typed, will cause the coordinates to be transmitted to the host (see below for format). If any character with ASCII code less than 32 (any CTRL character) is typed, the code is passed straight to the host.

On transmission, BYPASS condition is entered as above, and the transmission sequence is 5, 6 or 7 bytes exactly as for the ESC ENQ response, except that byte 1 contains the ASCII code of the printable character typed (or of SPACE if a fire button was used), instead of the status byte. Bytes 6 and 7, as above, contain the GIN terminator as selected on SETUP.

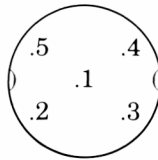
Appendix G

Connecting the terminal to a host computer or modem

This Appendix gives wiring details of the connections required between the RS423 socket on the back of the BBC Microcomputer and the modem or host to which you wish to link it. Most users should not need to refer to this section, unless difficulties arise.

G.1 The serial interface DIN connector

The signal connections to the serial interface socket, viewed from the rear of the microcomputer, are:



- 1 Signal Ground – Common Return
- 2 CTS – Clear To Send (signal to the BBC Microcomputer)
- 3 TXMT – Transmit Data (data from the BBC Microcomputer)
- 4 RCV – Receive Data (data to the BBC Microcomputer)
- 5 RTS – Request To Send (signal from the BBC Microcomputer)

The mating 5 pin ‘domino’ plug can be inserted in two orientations, only one of which can be correct. The above figures normally label the pins of the connector, which commonly has a notch for location within its headshell between pins 2 and 3. The headshell cutout, if there is one, will then be at the top of the connector as it is plugged into the microcomputer.

G.2 Using the serial interface

The signals and voltage levels of the serial interface conform to the RS 423 standard. In practice this also allows connection to equipment using the older, but still very common, RS232 or V24 interface specification.

In the terms of these standards the microcomputer is a DTE (Data Terminal Equipment) which is to be connected to a DCE (Data Circuit Terminating Equipment). DTEs and DCEs may support many 'interchange circuits' or signals, only a few of which are likely to be available on any particular piece of equipment. The connection of a terminal is thus likely to involve a certain amount of signal swapping to achieve the desired effect. Fortunately trial and error usually yields results reasonably rapidly. The specification of the signals ensures that accidental shorting can be tolerated indefinitely, so experimentation is quite in order if further information or assistance cannot be obtained. The signals available at the microcomputer's serial interface are:

Signal Ground or Common Return is the reference for the other signals. It should not be connected to protective earth or equipment casing.

CTS – If Clear To Send is asserted, ie at a high level, then characters typed will be transmitted, otherwise they will be buffered until CTS becomes high. This signal must be supplied to the microcomputer. How this is done depends on the terminal line, computer, or modem to which you are connected and you should consult the appropriate manuals or system experts. The answer is likely to be one of:

- a) Connect to the RTS signal output of the BBC Microcomputer. This can be done within the shell of the domino plug without external connections.
- b) Connect to the Clear To Send signal provided by the DCE.
- c) Connect to the DCD (Data Carrier Detect) signal generated by the DCE. It is usually advisable to do this if the DCE in question is a modem.
- d) Connect to a convenient, usually DCE provided, high level. Anything between four and twelve volts with respect to common will do.

RTS – If Request To Send is asserted then the terminal is ready to send and receive data. This signal is held at a high level even if there isn't a character awaiting transmission. It may have to be connected to the Ready To Send or Data Terminal Ready inputs of the DCE, or even both at once.

TXMT – Transmit Data from the BBC Microcomputer terminal.

RCV – Receive Data sent to the terminal.

G.3 Connectors for other computers, terminal lines and modems

A variety of connectors have been used for serial interfaces but the standard, and by far the most common, is the 25 way 'D type' connector. A DTE, such as the BBC Microcomputer, should be equipped with a cable terminating in a 25 way D-type plug, the pin assignments for which are:

- 1 Protective Ground (should not be used)
- 2 Transmit Data (from the DTE)
- 3 Receive Data (to the DTE)
- 4 Request To Send (signal from DTE)
- 5 Clear To Send (signal to DTE)
- 7 Signal Ground (common return)
- 8 Data Carrier Detect
- 20 Data Terminal Ready

As mentioned above, only a few of these may need to be connected, and it is most likely that the cable required to connect your BBC Microcomputer as a terminal will be one of the following:

	DIN		D-25 plug		DIN		D-25 plug		
GND	1	_____	7	GND	GND	1	_____	7	GND
TXMT	3	_____	2	TXMT	TXMT	3	_____	2	TXMT
RCV	4	_____	3	RCV	RCV	4	_____	3	RCV
RTS	5	_____	4	RTS	RTS	5	_____	4	RTS
CTS	2	_____	5	CTS	CTS	2	_____	5	CTS

	DIN		D-25 plug
GND	1	_____	7 GND
TXMT	3	_____	2 TXMT
RCV	4	_____	3 RCV
RTS	5	_____	20 DTR
CTS	2	_____	8 DCD

If you are connecting to another computer rather than a modem you may well find that is equipped with a 25 way plug rather than a socket (it too is a DTE!) and that, plug or socket, it has been wired the wrong way round. Unfortunately the latter problem occurs frequently. You can either, after appropriate consultation, make up a special cable for that particular item of equipment or wire a very short additional cable or crossover box. This last course of action has much to recommend it as it can eliminate future problems concerning non-standard cables and extensions.

A useful tool for connecting to a variety of systems is the 'null modem' comprising two 25 way D-sockets wired back to back, with TXMT and RCV, RTS and CTS, DCD and DTR exchanged to permit the direct connection of two DTEs.

For diagnostic purposes, a 'loop-back' plug in which TXMT (3) is connected to RCV (4) and RTS (5) to CTS (2) is also useful. This can help to check that the BBC Microcomputer and Termulator are functioning as expected, and that any transmission problems are originating further 'downstream'.

Glossary

ANSI: the American National Standards Institution; a set of standards for terminal interfacing; a terminal conforming to a subset of the ANSI standards.

ASCII: the American Standard Code for Information Interchange; a standard code for representing printable characters, control codes etc by 7-bit characters. ASCII is used by most communications systems and mainframe computers.

Autorepeat: the feature of the BBC Microcomputer whereby a key held down for more than a short time 'repeats' the character at constant intervals.

Baud rate: a measure of the speed at which data is transmitted over a communications link. For typical baud rates see Appendix A.

Control code: an ASCII character which does not represent a printable character but has some other effect on the terminal or computer in use. In ASCII, codes less than 32 are control codes. See Appendix C.

Cursor: a marker on a screen (usually a flashing line or block) which marks the position at which typed characters etc will be placed or some other operation will take effect.

Cursor keys: the four 'arrow' keys at the right hand side of the BBC Microcomputer keyboard, which are normally used to move the cursor about the screen.

Dumb terminal: a terminal which simply transmits and recognises printable characters and a few other basic controls, and does not have graphics facilities or other special features.

Dump: a copy (usually printed) of a VDU screen or of part of a computer's memory. The Termulator provides facilities for a 'screen dump'.

Duplex: the mode of data transmission whereby characters sent are reflected back to the sender by the host.

Econet: the local area network which connects several BBC Microcomputers (or other Acorn computers) to each other and to a central filing system; the associated filing system.

Emulation: the process of one computer, terminal or system 'pretending' to be another, by running suitable specialised software.

Escape sequence: a sequence of characters beginning with the ASCII ESC character, used by host or terminal to transmit special instructions, usually for control purposes. A set of standard escape sequences is defined by various ANSI standards. See Appendices D and E.

Flow control: the method whereby part of a communications link can control the flow of data, in particular to limit the rate at which data is received to the rate it can be handled. The use of X-ON and X-OFF characters is a standard way of implementing flow control.

Function keys: the red keys on the top row of a BBC Microcomputer keyboard.

Function key card: the card designed to fit above the function keys on the BBC Microcomputer keyboard which lists the effects of those keys.

GIN: Graphics input mode in a Tektronix terminal or emulator; the mode in which the user can send to the host the coordinates of a point on the screen.

Glass Teletype: another expression for a dumb terminal, q.v.

Hard copy: paper or other 'permanent' copy of text or drawings. The 'hard-copy' terminal produces all its output on a printer rather than a screen.

Hard reset: on the BBC Microcomputer, the effect produced by pressing CTRL and BREAK. This normally clears some parts of the memory and re-instates the 'default' language, filing system etc.

Host: the computer system to which a terminal is connected; often a large 'mainframe' system or minicomputer to which many terminals may have access at the same time.

Interlace: a feature of the way TV signals are normally fed to a TV screen or monitor. Some screens, and some programs, are easier to use with interlace switched off; see Appendix A.

Line break: on a communications system, an interruption of the signal on the line. A line-break (typically 230 ms long) can be generated by a terminal user and detected by the receiving hardware; it is often used to interrupt processing.

Menu: on a computer system, a list of actions or items from which the user is asked to choose one.

Parallel interface: one of the standard means by which computers communicate with devices such as printers. The BBC Microcomputer has a 'parallel printer port' which is a socket to which a parallel-interface (Centronics-compatible) printer can be connected.

ROM: Read-only memory: the type of computer memory used to store certain programs ‘permanently’ on a silicon chip. Also used to signify the chip itself. See ‘Sideways ROM’.

RS423: a standard defining ‘serial’ connections between computers and various other devices. On the BBC Microcomputer the RS423 socket is used with Termulator for connecting to a modem or host. See Appendix G. RS232 is an older standard; equipment conforming to RS232 can (in theory) be connected directly to the RS423 socket.

Serial interface: a type of connection between computers and various devices. The RS423 standard is one form of serial interface. Serial interface printers can be used with the BBC Microcomputer, but not in conjunction with Termulator because both require the RS423 socket.

Sideways ROM: on the BBC Microcomputer, a ROM chip inserted in one of the special ‘sideways ROM’ sockets, and containing a program, filing system etc which can be run directly from the ROM.

Spooling: on the BBC Microcomputer, the action of copying all information sent to the screen to a disc or other file.

Soft keys: see function keys, above.

Terminal: a device used to communicate with a host computer, usually including a keyboard and a display or printer. A terminal may be a computer in its own right or a simpler device used only as a terminal.

Termulator: the Acornsoft terminal emulator for the BBC Microcomputer.

V24: a standard for serial interface connections, similar to RS232. See RS423.

VDU: Visual display unit; the screen display used by a computer terminal. The ‘VDU driver’ in the BBC Microcomputer controls the TV or monitor display, and ‘VDU codes’ are specific control codes used by the VDU driver; see the BBC Microcomputer System User Guide.

Video: in text displays, ‘normal video’ usually means a white-on-black display, and ‘inverse video’ means black-on-white.

VT100: a sophisticated computer terminal device which implements most of the relevant ANSI standards. The ‘ANSI’ option in Termulator emulates a terminal resembling a VT100.

Wraparound: the feature on a terminal whereby lines too long for display are split, and continued on the next line. See Appendix A.

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