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0. Introduction

The CONCEPT™ Keyboard is an original data input device for computers offering many advantages over other data entry systems and designed to reduce or even eliminate the need for people to use the standard 'QWERTY' or typewriter style keyboard. Extensively used on the BBC microcomputer and many other machines, the CONCEPT™ Keyboard has gained popularity by virtue of its ability to operate with pictorial overlays which relate directly to the program being run.

It is comprised of a touch sensitive membrane keyboard, a microprocessor based circuit board with parallel and serial I/O, mounted in a rugged low profile aluminium case. The touch area has 128 individual keys and is made of wipe clean, scratch resistant polyester, with under surface printing.

Each key generates a fixed 8 bit code which can be assigned to characters, words, commands, or icons in user software and mapped on to an overlay on the touch surface.

The CONCEPT™ Keyboard can be used to allow young and inexperienced users to interact with the computer using items such as colours, pictures and geometric shapes when operated in conjunction with suitable software.

1. How to use this manual

This manual is designed to provide the user with guidance on the connection and use of the CONCEPT™ Keyboard in conjunction with pre-existing software designed to operate with it. It is not intended to provide detailed technical information on the construction of the CONCEPT™ Keyboard, nor any guidance on how to write application software. If you are in need of additional technical information not covered by this manual, please contact Star Microterminals direct.

Sections two and three of this manual should be read by everyone - even if you are already familiar with CONCEPT™ Keyboards. The instructions there will help you to install and use the keyboard.

Section four discusses in general terms the issues of application software and again is primarily of interest to teachers, while section five deals with care and handling of your CONCEPT™ Keyboard. Section six gives you some information on troubleshooting in the unlikely event that you are experiencing problems with your keyboard. These three sections may be safely omitted from a first reading of this manual.

Finally, section seven and the appendices contain some technical information which will only be of interest to programmers and the very curious; it may be safely ignored by everyone else.

2. Getting Started

This section should be read by all users who are not thoroughly familiar with CONCEPT™ Keyboards. Even if you are, there is always the possibility that you might learn something new!

2.1 Unpacking

The CONCEPT™ Keyboard should have been shipped to you in a protective package.

Remove the CONCEPT™ Keyboard from its protective enclosure, taking care to set aside for the moment the master overlay sheet and any software which may be shipped with your unit. It is suggested that you keep the packaging and reuse it to store your keyboard when not in use or when transporting it to another site.

You should have the following items:-

* This guide
* An A4 (or A3) CONCEPT™ Keyboard with connecting lead (parallel or serial)
* A transparent master overlay sheet of matching size
* A mains power supply module (certain serial versions only)

Please carefully examine the keyboard and its lead and connector and notify your supplier immediately in the event that there is any sign of damage. If any damage is evident, it is wise not to attempt to connect and use your CONCEPT™ Keyboard.

2.2 Connecting the CONCEPT™ Keyboard

The CONCEPT™ Keyboard is available with either an 8-bit parallel interface or serial (RS232) interface; the latter with factory set baud rates. Since there is a large variety of computers to which the CONCEPT™ Keyboard may be attached, the descriptions given below

are limited to the BBC (parallel) and generic serial versions.

For details of how to connect the CONCEPT™ Keyboard to a particular computer, please consult Star Microterminals Ltd.

2.2.1 Parallel version

The parallel version of the CONCEPT™ Keyboard is supplied with a ribbon cable fitted at one end with a 25-way D-type socket, and at the other with a 20-way IDC socket.

With power turned off, plug the D-type socket into the matching connector on the CONCEPT™ Keyboard and the IDC socket into the matching plug on your computer. In the case of the BBC model B and Master, the correct plug is identified as the 'User Port' and is located beneath the main keyboard unit.

2.2.2 Serial version

The serial version of the CONCEPT™ Keyboard will normally be supplied with a special split lead and an external power supply module. Plug the 25-way D-type socket into the mating connector on the CONCEPT™ Keyboard and the other end of the lead into the serial interface of your computer. Connect the power supply module via the flying leads and plug into a suitable outlet socket.

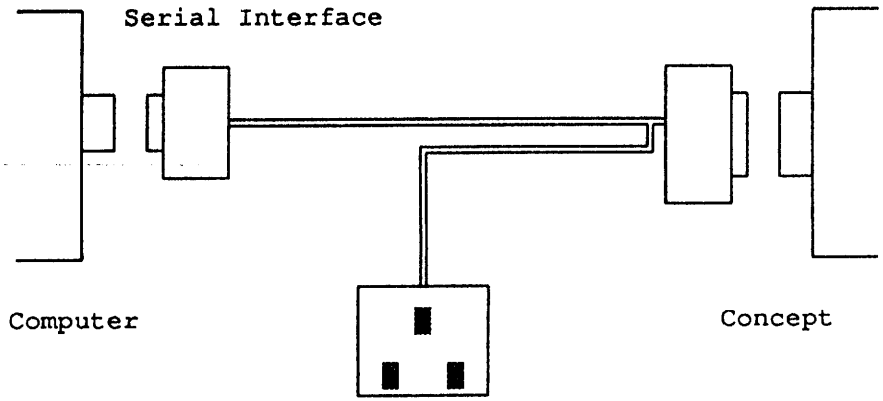
Note that it may be necessary to configure your serial port to match the settings of the CONCEPT™ Keyboard before running any software. Consult your computer handbook on how to do this, the settings you will need are defined in Appendix A of this manual under the heading of 'Serial Interface Specifications'.

It is also possible to make up your own lead for special applications or unusual serial configurations. Some examples of the neccessary wiring arrangements are given in Appendix B. If you plan to provide your own external power supply to the CONCEPT™ Keyboard, make sure that you check the following points carefully; Star Microterminals will take no responsibility for damage caused by improper use.

i) Check whether your CONCEPT™ Keyboard is fitted with a voltage regulator. Appendix A lists the voltage requirements for the units with and without the regulator option.

ii) Ensure that the power supply you intend to use is capable of supplying the required current and that its output voltage specification matches that required by the CONCEPT™ Keyboard.

iii) Take care to connect the power supply to the appropriate pins on the keyboard and that the polarity is correct. Failure to observe these rules will almost certainly result in the destruction of your CONCEPT™ Keyboard.



Connecting a Serial Interface Concept

3. Operation

The main keypad area on the CONCEPT™ Keyboard consists of a rectangular array of 128 membrane keys arranged in a grid of eight rows by sixteen columns. These keys are numbered from 0 to 127. In addition, there are four control keys situated along the upper edge of the keyboard and labled 'USER', 'REPEAT', 'BLEEP ON/OFF' and 'SHIFT LOCK'.

Each of the keys is touch sensitive over the whole of the area designated by the key outline printed on the top surface and requires only light finger presure to activate it. Continuous heavy pressure or the use of any object other than a finger to press keys (such as a pencil) should be strongly discouraged as this may cause damage to the membrane switch and failure of the unit.

3.1 Normal keys

Each time one of the keys in the main area is pressed, the CONCEPT™ Keyboard sends a numeric code to the computer. The code sent corresponds to the number printed on the key area (0-127) or, if the 'SHIFT LOCK' is active, (as indicated by the LED) that number plus 128, i.e., from 128 to 255. This code will normally be interpreted by the program running in the computer and so you do not need to concern yourself with its significance.

If the internal beeper is turned on, each time a key is pressed and a code is sent, the CONCEPT™ Keyboard emits a short 'beep' to let you know that it is working.

If you should press two keys at the same time, only one of them will be effective. In fact, you can press several keys at once but only one code will be sent to the computer. Before you can send a different code, all the keys must first be released.

3.2 User Pad

The key labled 'USER' is not connected to the internal circuitry and is provided for the user to attach his own equipment. It is a simple on/off switch designed to control low level circuits such as a small lamp or relay. Connection details are given in Appendix A.

NOTE: FOR YOUR OWN SAFETY ENSURE THAT NO HIGH VOLTAGES ARE CONNECTED TO THE CONCEPT™ KEYBOARD. THE SWITCHES ARE DESIGNED ONLY TO HANDLE LOW POWER.

3.3 Repeat

The 'REPEAT' key provides you with the ability to repeatedly send the same code in response to a single press of a key. Press and hold the 'REPEAT' key at the same time as the normal key in order to continuously send the same code. The LED next to the 'REPEAT' key will flash each time the code is transmitted.

3.4 Shift Lock

This key is used to control the 'shift state' of the keyboard. Press the 'SHIFT LOCK' key once to enable the shift state (LED illuminated), press it again to revert to normal state.

In normal state, (LED extinguished), the keyboard will send codes in the range 0 to 127 when a keypad is pressed. When in shift state (LED illuminated), the same keys will send codes in the range 128 to 255.

4. Software and the CONCEPT™ Keyboard

Since it is assumed that you will normally be using software specially written for use with the CONCEPT™ Keyboard, such as Prompt/Writer, no detailed information is given in this manual about programming. Sufficient information is included in the publications associated with each software package to explain how to set up and use it.

If you are interested in pursuing the technical details of programming and use of the computer's interface ports, most of the essential information will be contained in the manuals supplied with your computer. In addition, the technical reference sections at the end of this manual will give you the further information you will need about the characteristics of the CONCEPT™ Keyboard attached to the BBC and other computers.

5. Caring for your CONCEPT™ Keyboard

The CONCEPT™ Keyboard will normally give you many years of trouble free service. However, as with all such equipment, a little care goes a long way towards preventing any problems. Please read the following advice carefully.

5.1 Cleaning

The CONCEPT™ Keyboard will, inevitably, over a period of time accumulate a layer of dust. This will do no harm but the appearance of the keyboard may benefit from an occasional wipe with a clean, damp cloth.

Although the CONCEPT™ Keyboard is manufactured from tough materials, take care not to use any abrasive materials such as scourers or any cleaning agents, either of which could damage the paint finish or the membrane surface.

5.2 Handling

The CONCEPT™ Keyboard is designed to be rugged and durable but still does not appreciate being dropped, stood on or otherwise abused. Please also take care not to use sharp implements (like pencils!) to press keys, you may puncture the membrane surface.

Do not apply unnecessary strain to the lead and connectors and always ensure that there is some slack in it when using the CONCEPT™ Keyboard on the desktop. When removing the connector from the keyboard, take care not to pull on the cable and ensure that the locking screws are fully released.

Although the CONCEPT™ Keyboard will continue to operate satisfactorily at temperatures which you would find unbearable, it should not be subjected to extremes of hot and cold. In particular, avoid standing the unit in direct sunlight or on a radiator and do not place hot objects such as a cup of coffee on the membrane surface.

Keep the CONCEPT™ Keyboard in a dry area and at temperatures which are not too different to those in which it will be used.

6. Troubleshooting

It is most unlikely that you will experience any problems with the CONCEPT™ Keyboard itself, however, if it does not appear to be working properly, check the following points.

Symptom	Check these
No response from keyboard, and no sound from beeper.	Is CONCEPT™ Keyboard plugged into the correct interface socket? Is the computer turned on and the keyboard powered up? Has the interface port been properly configured and are you running software designed to support the CONCEPT™ Keyboard? Is more than one key being pressed at the same time?
When pressing a key, the 'DATA' LED flashes but no beep is heard.	Beeper is turned off

The CONCEPT™ Keyboard does not seem to be sending the right information.	Check that the 'Shift state' is correct for the software you are running. Most software uses the keyboard with the shift state 'off'. Check the connections to your computer interface Check that the settings for your interface port are correct e.g. baud rate, parity etc. (Serial versions)
Holding down the 'REPEAT' key does not cause the code to be repeated.	Check that you are also pressing the normal key you want to repeat! If all else fails try return the complete unit to your supplier for servicing and repair.

7. Technical Reference

This section is for reference purposes only. You do not need to read it unless you either:-

a) are incurably curious and just want to know more about how it all works

or

b) have some intention of writing your own programs.

7.1 Background

The keys on the CONCEPT™ Keyboard are made up from a matrix of conductors printed in silver ink and arranged in overlapping rows and columns. The conductive strips are normally separated by a fine air gap, created during manufacturing by a carefully controlled screen printing process. The electronics consists of a printed circuit board carrying logic to scan and sense the keyboard state.

When a key is pressed, the resulting contact is sensed by the on board microprocessor and a determination made of which key has been pressed. This key number will always be in the range 0 to 127, corresponding to an 8-bit code with the most significant bit set to 0. However, if the shift state is on, the most significant bit will be forced to a '1', effectively adding 128 to the code sent to the computer.

If the repeat key is off, keyboard scanning is then suspended until the key is released. However, if the repeat key is held on, keyboard scanning is resumed and, if the same key is still pressed, the previous code transmission is repeated.

Power to the CONCEPT™ Keyboard is provided either by the BBC computer via the User port as five volts DC (parallel versions) or as an unregulated 8 to 12v from an external power supply module (for serial versions fitted with the regulator option). This latter supply is

regulated by the internal regulator down to the 5 volts necessary for the logic.

7.2 Programming

If using the CONCEPT™ Keyboard on a BBC B or Master series computer with the parallel 'User Port' interface, then one of the following procedures can be used.

In BBC BASIC:-

```
10 REPEAT
10 PROCCK
20 PRINT CK;" ";
30 UNTIL CK=0
40 STOP

3000 DEFPROCCK
3010 ?&FE60=&00
3020 ?&FE62=&00
3030 ?&FE6B=&02
3040 REPEAT UNTIL ?&FE6D=16
3050 CK=?&FE60
3060 ENDPROC
```

Program description:

Lines 10 to 30 calls the keyboard procedure PROCCK. When a key is pressed on the concept its decimal value is displayed on the screen. This will continue until key 0 is pressed which has the effect of stopping the program.

Line 3010 clears the user port and any flags that may have been set.

Line 3020 sets the data direction for all bits of the port to input.

Line 3030 sets the port to latched mode (the data present on the port when the negative strobe goes high-low is latched in).

Line 3040: The program waits until the CB1 flag is set (negative strobe has gone high-low).

Line 3050: The variable CK is then set to the value that has been latched into the port from the Concept keyboard

(This also has the effect of clearing the CB1 flag) and then exits the procedure.

If the codes 0 to 127 are required to be output irrespective of the shift status of the Concept keyboard the line 3050 should be replaced with:-

```
3050 CK=?&FE60 AND &7F
```

This has the effect of making the 7th bit always low.

Running the Concept under Interrupt

The following program will place any Concept key press into the BBC keyboard input buffer, under interrupt. The Concept will act as a second keyboard.

```
10 CLS
20 ?&FE60=&00
30 ?&FE62=&00
40 ?&FE6B=&02
50 ?&FE6D=&90
60 ?&206=0:?&207=&C
70 FOR I=0 TO 2 STEP 2
80 P%=&C00
90 [OPTI
100 PHA
110 TXA
120 PAH
130 TYA
140 PHA
150 LDA #&96
160 LDX #&60
170 JSR &FFF4
180 LDA #&8A
190 LDX #0
200 JSR &FFF4
210 PLA
220 TAY
230 PLA
240 TAX
250 PLX
260 CLI
270 RTI
280 ]
290 NEXT
```


Comments:

Lines 20 to 40 configure the BBC user port to be an input which latches incoming data from the Concept, and will also create an IRQ interrupt on receipt of the negative strobe.

Line 50 determines the address to which the program jumps on receiving a Concept interrupt. The address chosen is &C00 but may be altered along with line 70 to suit your needs.

Line 60 is used to assemble the machine code.

Line 80 is the start of the machine code routine.

Lines 90 to 140 saves all the microprocessor registers.

Lines 150 to 170 fetches the concept keypress.

Line 180 to 200 stores the Concept key in the BBC keyboard buffer.

Lines 210 to 250 restores the three registers A, X, Y, to their original state.

Line 260 clears the interrupt mask, and returns from the interrupt to what ever the processor was doing before.

Line 270 is the end of the machine code routine.

For example, after running the above program, press the following keys on the Concept:-

76,73,83,84,13 = LIST CR

You have just listed a program without using the BBC keyboard!

Using a serial port

When configuring a serial port of your computer to work in conjunction with the CONCEPT™ Keyboard, ensure that the appropriate commands are given to set the port up to the same parameters as the keyboard. (See appendix A for details).

For example, if using an IBM PC or similar running MS-DOS and with the CONCEPT™ Keyboard connected to COM1, the command:

```
mode com1:4800,n,8,1
```

will set up the serial port to 4800 baud operating with 8-bit data, no parity and one stop bit. Data from the CONCEPT™ Keyboard can then be read in using any of the standard language calls to the serial port, for example:


```
10 REM: This short program demonstrates the use of the
20 REM: CONCEPT™ Keyboard as an RS232 terminal on a PC
30 REM:
40 REM: First: Define file #1 as the serial port
50 REM:              'COM1:' at 9600 baud,
55 REM:        with no parity and 8 data bits
60 REM: Note that these settings must match
130 REM:       the factory set baud rate
140 OPEN "COM1:9600,N,8,1,RS,DS0" AS #1
150 REM:
210 REM: Statements 310 to 360 form a loop in the
215 REM: program, continuously reading a single
220 REM: character from file #1 - the COM1 port
230 REM:
240 REM: Line 310 looks for key 12 (Line Feed) to be
250 REM: pressed on the CONCEPT and terminates the
260 REM: program if detected
270 REM: Line 330 converts the character received into
300 REM: its numeric value
310 WHILE (AEY$ <> CHR$(12))
320       AEY$ = INPUT$(1,#1)
330       KEYNUM% = CVI(AEY$+CHR$(0))
340       PRINT "YOU HAVE PRESSED KEY ";AEY$, KEYNUM%
360 WEND
370 PRINT "All done!":BEEP
```

Appendix A - Specification

Keyboard:

Touch sensitive membrane type. The touch surface consists of a flat, wipe clean, scratch resistant polyester with undersurface printing. It has 128 individual touch keys in a 16 x 8 matrix.

LED's

There are three LED's on the Concept MKII keyboard.

1) The Power LED. This indicates that the unit is on.

2) The Data Accept LED. This flashes on and off every time a key is pressed.

3) The Shift LED. This indicates the shift status. If the Led is on then codes 128 to 255 are output from the Concept.

Bleeper

An audible bleep is provided to indicate that a key has been pressed. The bleep can be turned on or off by pressing the Bleep on/off key.

Mechanical Dimensions:

Frame:	314 x 227 mm. (A4) 437 x 314 mm. (A3)
Height:	25 mm.

Note that the overlay area is designed to accomodate a standard sized sheet of A4 or A3 paper as appropriate.

Power Requirements:

Parallel and non-regulator options:	5 Volts DC + / - 0 . 2 5 V Stabilised @ 140mA max.
Serial versions fitted with regulator:	8 to 12v DC @ 140mA max.

Electrical Specifications:

DB0 to DB7, +VE Strobe, and -VE Strobe can drive 10 LSTTL loads.

+VE and -VE Strobe pulse width:	8ms +/- 10%
Key 'on' debounce time:	20ms
Key 'off' debounce time:	80ms
Maximum User pad voltage:	24V DC
Maximum User pad current:	5 ma
Optimum temperature range:	0 deg.C to 38 deg.C
Average force required to operate membrane key:	300 g

Serial Interface: (Option)

An RS232C asynchronous serial interface is available as an option.

Baud Rates:	Factory set from 300 to 9600
Parity:	None
Data bits:	8
Stop bits:	1

ASCII Codes output by the Concept MKII

(UNSHIFTED)

Most Significant \ Least Significant Hex Digit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	

The first 33 codes explained

Concept Key Number	ASCII Char	Hex	Code	Comments
0	NUL	00	Control @	Null
1	SOH	01	Control A	Start of heading
2	STX	02	Control B	Start of text
3	ETX	03	Control C	End of text
4	EOT	04	Control D	End of t'mission
5	ENQ	05	Control E	Enquiry
6	ACK	06	Control F	Acknowledge
7	BEL	07	Control G	Bell
8	BS	08	Control H	Backspace
9	HT	09	Control I	Horizontal Tab
10	LF	0A	Control J	Line feed
11	VT	0B	Control K	Vertical Tab
12	FF	0C	Control L	Form Feed
13	CR	0D	Control M	Carriage Return
14	SO	0E	Control N	Shift out
15	SI	0F	Control O	Shift in
16	DLE	10	Control P	Data link escape
17	DC1	11	Control Q	Device control 1
18	DC2	12	Control R	Device control 2
19	DC3	13	Control S	Device control 3
20	DC4	14	Control T	Device control 4
21	NAK	15	Control U	Negative Ack.
22	SYN	16	Control V	Synchronous Idle
23	ETB	17	Control W	End of T's Block
24	CAN	18	Control X	Cancel
25	EM	19	Control Y	End of Medium
26	SUB	1A	Control Z	Substitute
27	ESC	1B	Control [	Escape
28	FS	1C	Control /	File separator
29	GS	1D	Control]	Group separator
30	RS	1E	Control ^	Record separator
31	US	1F	Control _	Unit separator
32	SP	20	Space	Blank

Appendix B - Connecting the Concept MKII Connector details

CONCEPT™ Keyboard 25 Way D type Plug:

Pin No.	Function
1	User pad
2	User pad
3	Data bit 7 Most significant bit
4	No connection
5	0v (ground)
6	Data bit 6
7	Data bit 5
8	Data bit 4
9	Data bit 3
10	Data bit 2
11	Data bit 1
12	Data bit 0 Least significant bit
13	Negative Strobe
14	Positive Strobe
15	No connection
16	No connection
17	RS 232 serial data out
18	No connection
19	No connection
20	No connection
21	No connection
22	No connection
23	No connection
24	Unregulated supply in (+8 to +12v)
25	Regulated +5 volts input

Parallel interface with BBC B / Master computers.

Concept D type plug BBC B / Master User port

Pin No.	Function	Pin No.	Function
1	User Pad	-	-
2	User Pad	-	-
3	Data bit 7	20	PB7
4	Not used	-	-
5	Ground (0 Volts)	19	0 Volts
6	Data bit 6	18	PB6
7	Data bit 5	16	PB5
8	Data bit 4	14	PB4
9	Data bit 3	12	PB3
10	Data bit 2	10	PB2
11	Data bit 1	8	PB1
12	Data bit 0	6	PB0
13	Negative Strobe	2	CB1
14	Positive Strobe	-	-
15	-24 Not used	-	-
25	+ 5 Volts	1	+5 Volts

The Concept to BBC interface lead is wired as above using a ribbon cable. Pin 1 is indicated by a red coloured wire on the ribbon cable and/or an arrow on the IDC ribbon cable connector.

Concept to BBC Serial Connections:

Concept Keyboard (25 Way D type plug) BBC RS423 Serial Port (5 pin DIN domino socket)

Pin No.	Function	Pin	Function
17	RS232 Transmit	A	Data in
5	System Ground	C	0 Volts
		E	RTS
25	+5V Supply	D	CTS
		B	Not Used

+5V 0V External Supply