WATFORD ELECTRONICS
BEEB VIDEO DIGITISER

OPERATING MANUAL

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All references to the BBC Microcomputer in
this manual refer to the British Broadcasting
Corporation Computer, produced by Acorn Computers
Ltd.

All references to AMX ART in this manual refer
to the AMX Package produced by Advanced Micro
Systems Ltd.

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BEEB VIDEO DIGITISER

1.0 Introduction

   The Beeb video digitiser converts standard
video signals into a graphics display on the
BBC micro. Any source of composite video, in
colour or monochrome, may be used. Screens are
produced in graphics modes 0, 1 or 2. The
video source can be a camera, video recorder,
or suitably equipped television. Connection to
the digitiser is from the "Video Out" socket
found on these devices.

   Once a graphic screen has been created, the
image may be processed as you wish. It can be
compressed and stored on disc, printed on an
Epson compatible printer, or otherwise
processed by your own software.

   The output from the digitiser matches the
graphics capability of the selected mode,
giving up to 8 levels of grey in mode 2. The
picture is automatically scanned once every 1.
6 seconds. Communications between the
digitiser and the computer are through the
User Port.

   The Black and White levels are adjustable.
This is so that the darkest parts of the
picture may be made black, and the lightest
parts white. Thus making maximum use of the
limited grey scale available on the BBC micro.
The adjustment can be performed manually by
the user, or automatically by the unit.

The image can be "inverted" to produce a photographic negative, i.e. black and white can be swapped over. This is useful if the video source supplies a negative picture.

The necessary software to control the digitiser is supplied in EPROM. The commands are accessed with "ˢ" and are used directly from Basic. The package is designed to allow screens to be read in as simply as possible. Once displayed on the screen, the picture may be manipulated independently of the software. Normal Basic commands or facilities from other ROMs may be used.

Whilst any screen dump routine can be used on the graphics image, a special printer dump routine is included. This is optimised to produce a correctly proportioned picture with reduced " contouring". This routine will, however, only work with Epson or Olivetti Sparkjet compatible printers.

2.0 Installation

For details of how to install the supplied EPROM please see the enclosed sheet. Note that the position of the EPROM is unimportant. As commands may be prefixed by "W", a low priority socket may be used even if higher ROMs intercept digitiser command names.

The operation of the EPROM may be checked by typing *HELP DIGIT which will list all of the digitiser commands.

The digitiser should be plugged into the User Port underneath the computer. Take care to connect the ribbon cable the right way round; there is a small notch on the plug which will only fit one way round. Power consumption is about 300mA. This will not overload the power supply unless you already have many peripherals drawing power from the computer, such as twin disc drives etc. Owners of the AMX Mouse will have to unplug the Mouse to connect the digitiser.

Connect the video signal to the BNC connector on the digitiser. This connection should be made with good quality co—axial cable.

2.1 Memory Usage

When in use the digitiser ROM uses certain memory locations. If a * command passes through the ROM, then no locations are corrupted; this gives maximum compatibility with other ROMs. When commands are in operation locations &80 to &8F are used and restored at the end of the command. Locations &BFO to &BFF are corrupted after a call, but this will not cause hardship under normal conditions.

3.0 Commands

   All commands to the digitiser start with a "*" and can be accessed directly from most languages. Commands cannot be abbreviated with ".", due to similarity of command names.

   As it is possible that other ROMs in your machine will use the same command names as the digitiser ROM, all commands will accept a "W" prefix. For example, *IMAGE can be replaced with *WIMAGE. The elimination of command clashes also means that the digitiser ROM can be placed in as lower priority as desired.

   Due to the speed of the display scan, screen memory is accessed directly. This means that any banked screen memory (such as the Watford 32k RAM Card) must be inactive during a screen scan. If this is not the case, then the image produced will reside in the additional bank of memory but no picture will be generated.

   Examples of the use of the following commands are given in section 6, where some simple programs are given.

3.1 *IMAGE (<N>)

  "N" = Negative

   When issued, this command will wait for the start of a frame from the digitiser and then display it.

   For this command to work correctly, the display must be in mode 0, 1 or 2, and must be unscrolled. The screen is set to an unscrolled state by the MODE or CLS commands. The Mode switch on the digitiser should be set to the same as the BBC display mode.

   Each *IMAGE command executed will cause a single scan of the screen. If you require continuous scanning to give animation you should put the *IMAGE command in a program loop. To display every scan generated by the digitiser the loop must take less than 200mS to execute, otherwise the start of a frame may be missed.

   When the *IMAGE command is executing the BBC's interrupt system is disabled. This means that the Escape key will not work, as well as various other interrupt driven functions. The timer will lose time and operation of buffered I/O will pause until the end of the scan. It is unfortunately possible for input channels to lose data during the scan so you should not attempt to input data whilst using the digitiser.

   If the command is followed by "N", then the image produced will be the negative of the input. This is of use if a picture is required from a photographic negative, or if the input is negated.

The error traps at the start of this command can be bypassed by using the command *DIRIM instead of *IMAGE.

3.2 *IMPRNT (< Aspect Ratio >)

Aspect Ratio Range = 1 to 200

This command gives a graphics dump on an Epson compatible printer. The dump will work in modes 0,1 & 2, and is especially written to provide a fast evenly toned dump.

If no aspect ratio is entered then a value of 100 is assumed. This produces the correct height to width ratio on most printers. If a value of less then 100 is entered the vertical dimension of the picture is reduced. If a value above 100 is entered the vertical dimension of the picture is increased. For values under 128 some scan lines are not printed. The aspect ratio should be in the range 1 to 200, giving a ratio range of 1:2 to 2:1. You should experiment with your printer to find the ideal value, which will depend on the camera used and the printer.

To avoid the printer being left in graphics mode, the Escape key will only work at the end of each line. Using the Break key may result in the printer being left in graphics mode and should be avoided if possible.

3.3 *OPRINT (< Aspect Ratio >)

Aspect Ratio Range = 1 to 200

This command gives a graphics dump on an Acorn / Olivetti Spark Jet printer. This dump will work in modes 0,1 & 2, and is specially written to provide a fast evenly toned dump on the Spark Jet printer.

Due to the nature of the Spark Jet printer it will produce very good printouts, without the characteristic horizontal bars produced by dot matrix types.

For other details see section 3.2

3.4 *IMSAVE <filename>

This command will save the currently displayed picture (or any screen), in Modes 0, 1 or 2, to the current filling system.

Normally the space required to save one of these screen modes would be 20K. By using a compaction algorithm, however, it is possible to store pictures much more efficiently. Complex pictures can be stored in about 12K, simple ones in as little as 1K. No detail is lost through this process.

The file produced can only be read back with the *IMLOAD command. If you want to produce an uncompressed screen image then you must save the whole screen memory with the command:

*SAVE <filename> FFFF3000 +5000

3.5 *IMLOAD <filename>

This command will re—display a screen previously saved by *IMSAVE, see Section 3.4.

The image is loaded directly to the screen memory. It is assumed that the screen mode in use when this command is issued is the same as when the image was produced.

If the screen was not saved using *IMSAVE then it can be retrieved with a normal load command:

*LOAD <filename> FFFF3000.

3.6 *IMART <filename>
    *MASK
    *IMMIX <filename>

This group of commands is designed to allow pictures taken by the digitiser to be transferred to the AMX ART program, which is supplied with the AMX ART Package.

These commands will convert any graphic display in modes 0,1 or 2 into a file for AMX ART. Typically these images will have been generated by the digitiser. The commands work on the screen currently in the memory.

Firstly the screen must be masked to the correct sized window with the *MASK command. This is followed by the *IMART <filename> command. This converts the display to mode 4 and simultaneously saves it.

If the screen is not first masked then the whole screen is converted and saved; this may be of use in other programs.

Due to the large reduction in screen resolution and area, the resulting picture is of much poorer quality than the original. None the less the image will provide a good basis for a sketch if the subject is chosen carefully.

To do a conversion from a digitiser image to AMX ART format perform the following:

a) Put the required image into a file using IMSAVE.
b) Save a blank AMX ART screen under the name BLANK.
c) Load and run the following Basic program, where NAME1 is the name of the source digitiser image file and NAME2 is the destination AMX ART file.

```
 10 INPUT "In what mode is the input file ",A%
 20 MODE A%
 30 *WIMLOAD NAME1
 40 *WMASK
 50 *WIMART NAME2
 60 MODE 4
 70 *LOAD NAME2 FFFF5800
 80 *WIMMIX BLANK
 90 *SAVE NAME2 FFFF5800 +2800
```

4.0 Adjustment

   Having attached the digitiser to the BBC
Micro you should switch on the system and
enter the following program:

```
10 MODE 2
20 *WIMAGE
30 GOTO 20
```

   Now connect your source of video to the
digitiser. Once the source is connected the
SYNC LED should flash, about once every two
seconds. If this does not happen see Section
7.1.

   Adjust the two switches on the front of the
digitiser to the "Mode 2" and "Auto"
positions. Enter "RUN" followed by Return and
within 4 seconds a picture should appear on
the screen. If you get an error message refer
to section 7.1. If the picture is broken up
see section 7.2.

   Having obtained some sort of picture you
should now adjust the level controls to give
the best possible picture. To do this switch
to Manual and rotate both knobs fully anti-
clockwise. For setting up it is easier to view
the picture in colour, though the image will
only look realistic in monochrome.

It will be assumed that the adjustment will be carried out in colour. The colours in modes 1 & 2 correspond to the grey scale as follows :-

Mode 2	Mode 1	Monochrome
Black	Black	Black
Blue	Black	Very Dark Grey
Red	Red	Dark Grey
Magenta	Red	Dark Mid-Grey
Green	Yellow	Light Mid-Grey
Cyan	Yellow	Light Grey
Yellow	White	Very Light Grey
White	White	White

When Mode 1 is viewed in monochrome, the colours Yellow and Red do not seem to be a very good choice for a good grey scale, although they are the standard colours in this mode . Matters may be improved by using one or both of the following commands:

VDU 19,1,5;0;<Return>
VDU 19,2,6;0;<Return>

To adjust the controls turn the black level slowly up until the darkest areas of the picture are displayed as black. Approximately 10% of the picture should be black. Then adjust the white level similarly until the lightest areas of the picture are displayed in white. As a guide to the correct setting, for a face the shadows in the hair should be black, and the nose/forehead should contain white areas.

Now that the levels have been set, small adjustments can be made to both level controls to resolve any detail required. As the levels are interlinked, any large change will require both controls to be zeroed and the whole re-setting cycle to be repeated.

5.0 Sources of Video

Almost any socket marked "Video Out" will produce a suitable signal for the digitiser. Video cameras and the direct output of a video recorder are suitable. Most sources can be connected with the use of a video connector kit, as supplied for a video recorder.

WARNING !!

Although the input to the digitiser is AC coupled it will not survive voltages over 12v. Also beware of sources where the outer of the connector is not a true ground. Be very cautious of video outputs added to units not intended to provide them, particularly from televisions. It is very common for such connections to be wired directly to one side of the mains, thus making them LETHAL. If in doubt consult a qualified technician.

5.1 Video Camera

This is the best source, as it is generally free from noise, and produces a very stable picture.

Most types of camera are suitable, whether colour or monochrome. The only types that cannot be used are older and very cheap cameras that produce random interlace.

Normally the camera will have to be plugged into a video tape recorder or mixer, to provide it with power. More professional cameras will be powered directly from the mains. The video out should be connected to the video digitiser with co-axial cable. Where a video recorder is used to provide power, this will leave a UHF or line output which can be viewed on a separate monitor or television. To focus the camera it will need to be connected to a monitor; it is very difficult to focus the camera using the digitised image.

With most video lenses there will be fall off of brightness in the corners, especially with wide angle lenses. This problem is most serious in Mode 0 where the use of a long focal length, >16 mm, is recommended. For problems that may arise when using a camera see section 7.3.

5.2 Video Tape Recorder

Using the Video Output socket, which is at the back of most video tape recorders, the digitiser can produce an image from either the tuner or tape. See section 5.3 on televisions for notes on using "off air" pictures.

When taking a picture from tape, the quality of the picture will depend very much on the quality of the source. When viewed normally the eye averages out, or is tricked into ignoring, faults in the picture. With the digitiser any faults that appear during the scan are permanently displayed. This means that great care must be taken, especially when using an old machine, or with poor quality tape.

A few hints to get the best results:

Use the best tape you can.
Stop on one frame while scanning and try to find a frame with no jitter on it.
Betamax seems to work better then VHS, although the newer VHS machines are much better.
Ensure that the recorder's heads are clean.

If the picture *was* recorded from the tuner read section 5.3.

For problems that may arise when using a video tape recorder see section 7.4.

5.3 Television or Video Tuner

First read the warning at the start of this section. Very few televisions have a video output, but the tuners on most video tape recorders do.

The quality of the picture required from a television or video recorder in order to produce a good digitised image is far greater than required for normal viewing or recording. The use of a good quality external aerial is necessary for noise—free results. Further improvements can sometimes be obtained by using an aerial amplifier. Signals radiated by the BBC computer itself can upset the tuner, so the computer should be kept away from the video/television. To obtain a good picture the signal must be very nearly noise free.

For problems that may arise when using a video tape recorder tuner or television see section 7.5.

6.0 Example Programs

6.1 Control from Basic

   The following program demonstrates the use of
the simplest digitiser commands from Basic.

   The first step is an input to set the Mode and
a simple loop to continuously scan.

```
  10 MODE 7
  20 INPUT "WHICH MODE, 0,1 or 2 ",M%
  30 IF MO OR M%>2 THEN GOTO 20
  40 MODE M%
  50 *IMAGE
  60 GOTO 50
```

   It would look better if the cursor was turned
off:

```
  45 VDU 23,1,0;0;0;0;
```

   Now test if a key has been pressed and if so
stop scanning.

```
  60 IF INKEY$(30)<>" " THEN GOTO 50
```

   The INKEY$ instruction does not quite wait
long enough to catch every keystroke but, if it
waited any longer, it would not loop in time for
the next scan.

```
  70 A$=INKEY$(50)
  80 IF A$="A" THEN GOTO 50
  90 IF A$="P" THEN *IMPRNT
  100 IF A$="S" THEN STOP
  110 GOTO 70
```

Using this program, the frame scan can be stopped by pressing the space bar. Once halted, pressing "A" will restart the scan, "P" will produce a printout and "S" will stop the program.

6.2 Machine Code

To pass commands to the digitiser ROM from within machine code use the OSCLI call. This is located at &FFF7 and requires the address of the command string in the X and Y registers (see Advanced User Guide page 107).

For example, to scan an image (in ROMAS source code) :

```
  OSCLI EQU &FFF7        ; Pass command to OS

IMAGE: LDX #LOW COMMAND ; Low Byte of
       command LDY #HIGH COMMAND ; High Byte
       CALL OSCLI       ; Do Command
       RTS

COMMAND: DB '*WIMAGE',13,0
```

7.0 Fault Finding

General:

   Video signals are very sensitive to poor
cables and badly made joints and so you must
use the correct cable for your leads; good
quality co-axial cable with the correct
connectors. You cannot just use a couple of
bits of wire twisted on as the results will
look appalling.

7.1 Sync Lamp not flashing:

a) Check User port bus cable. The only
connections required from the BBC to make the
lamp flash are +5v and GND.

b) Check the incoming video cable for a break.
This can very easily happen inside co-ax
cables.

c) Are you sure you are supplying a video
signal? Make sure you have not plugged into an
audio or UHF output.

d) Can your video source drive into 75 ohms,
or is the line now terminated twice? The
digitiser contains a 68 ohm terminator.

e) Does the video source contain a large
amount of noise or hum? This could be an earth
loop.

f) Is the source of video switched on?

7.2 Poor Synchronisation - Broken pictures:

a) See 7.1 d & e.

b) The digitiser will not work well with very old types of cameras that produce random interlace.

7.3 Poor picture from a Camera:

a) Signals radiated from the BBC computer can upset the camera. If the camera has a plastic lens body, cover it in metal foil and earth it to the camera body. Keep the camera away from the computer.

b) See 7.2 b & 7.1 d

c) Check that the camera output is lv P-P video and is expecting a 75 ohm terminator.

d) Check that the camera is in focus.

e) Fall off of brightness at the corners of the image is due to the characteristics of the lens.

f) Are you sure that the display and digitiser are in the same mode?

g) Large areas of white on the screen are caused by the video amplifier being overloaded. This means that the signal is >2v P-P, when lv P-P is specified. The best solution is to use a 3dB attenuator.

h) If the picture is dominated by black and white, the signal level is to low. See Section 7.1 d.

7.4 Poor Picture from video tape recorder:

a) If the picture was taken from the tuner see Section 7.5.

b) If the picture is split into vertical bars, this is due to mechanical tape jitter. Try again with the tape on "Play", or keep trying other still frames. You could also try using a better quality tape.

c) Using copied tapes will compound the problems.

d) Check that the display and digitiser are in the same mode.

e) See Section 7.3 g & h.

7.5 Poor Picture from Video or Television Tuner:
a) Signals radiated by the BBC computer can very easily upset the tuner. An outside aerial is almost certainly required.

b) Is everything correctly earthed? What passes for ground in some televisions, can be a very nasty voltage plus hum.
c) To obtain a good picture the signal must be very nearly noise free. Check this by looking very closely at the picture on your television.
d) Check that the display and digitiser are in the same mode.
e) See Section 7.3 g & h.

7.6 Blank Screen although everything seems to be working:

a) Make sure that any screen overlay memory (the Watford 32K RAM card, for instance) is switched off.

7.7 Error Messages:

a) BAD MODE . The commands in the digitiser ROM will only function in modes 0,1 & 2.

b) SCREEN SCROLLED . Most of the commands will only work if the screen has not been scrolled. Due to speed of operation there is insufficient time to calculate scrolled address. To reset the screen use a MODE command.

c) NO SYNC . The *IMAGE command will time out if the digitiser box has no video input. If this did not happen then the BBC would "hang", because interrupts are disabled during video input.