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Acorn

Risc PC monitor definition files explained

This application note describes in detail Risc PC monitor definition files. It should be read in conjunction with the !MakeModes documentation. !MakeModes is an application which assists the creation and editing of Risc PC monitor definition files.

The !MakeModes application and this application note assume a degree of technical knowledge concerning video display generation and is not intended for use by those unfamiliar with display technology.

Applicable Hardware : Risc PC range

Related Application Notes: !MakeModes

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Introduction

The Acorn Risc PC, unlike any previous Acorn machine, does not have information on screen modes built into the operating system. Screen modes are instead defined in a Monitor Definition File (MDF) which is loaded when the machine boots up. This provides the user of a Risc PC with a much greater degree of flexibility when it comes to choosing a monitor as screen modes can now be individually tailored to suit the facilities offered by the monitor.

Overview

A Monitor Definition File which normally resides in the `!Boot.Resources.Configure Monitors` directory is a plain text file which defines all of the parameters necessary for the Risc PC to generate and display RISC OS screen modes. An example segment of an MDF follows...

```
file_format:1
monitor_title:Acorn AKF60
DPMS_state:1

# 320 x 250 (70Hz)
startmode
mode_name:320 x 250
x_res:320
y_res:250
pixel_rate:12587
h_timings:36,14,12,320,12,6
v_timings:2,109,0,250,0,88
sync_pol:2
endmode

# 800 x 600 (75Hz)
startmode
mode_name:800 x 600
x_res:800
y_res:600
pixel_rate:49500
h_timings:80,46,42,800,42,46
v_timings:3,21,0,600,0,1
sync_pol:0
endmode

# 1024 x 768 (60Hz)
# High band
startmode
mode_name:1024 x 768
x_res:1024
y_res:768
pixel_rate:65000
h_timings:128,36,60,1024,60,36
#    VESA:136,160,0,1024,0,24
v_timings:6,29,0,768,0,3
sync_pol:0
endmode
```

Each screen mode that you wish to use should be defined as above within the monitor definition file. The application !MakeModes can be used to generate monitor definition files from data supplied by the user. It is available from your Acorn Dealer or local I.T. Centre. The application consists of a disc containing !MakeModes, a ReadMe file and an accompanying manual.

You are not advised to edit monitor definition files directly.

The parameters `file_format`, `monitor_title` and `DPMS_state` are set only once at the beginning of an MDF. The command `startmode` tells the machine that a mode definition follows. Below is a summary of all of the commands used in an MDF.

```
file_format:        format
monitor_title:      title
DPMS_state:         state

startmode
 mode_name:         mode_name
 x_res:             x-resolution
 y_res:             y-resolution
 pixel_rate:        pixel_rate
 h_timings:         hsync, hbpch, hlbdr,hdisp,hrbdr,hfpch
 v_timings:         vsync, vbpch, vtbdr, vdisp. vbbdr, vfpch
 sync_pol:          sync_polarities
endmode
```

where:

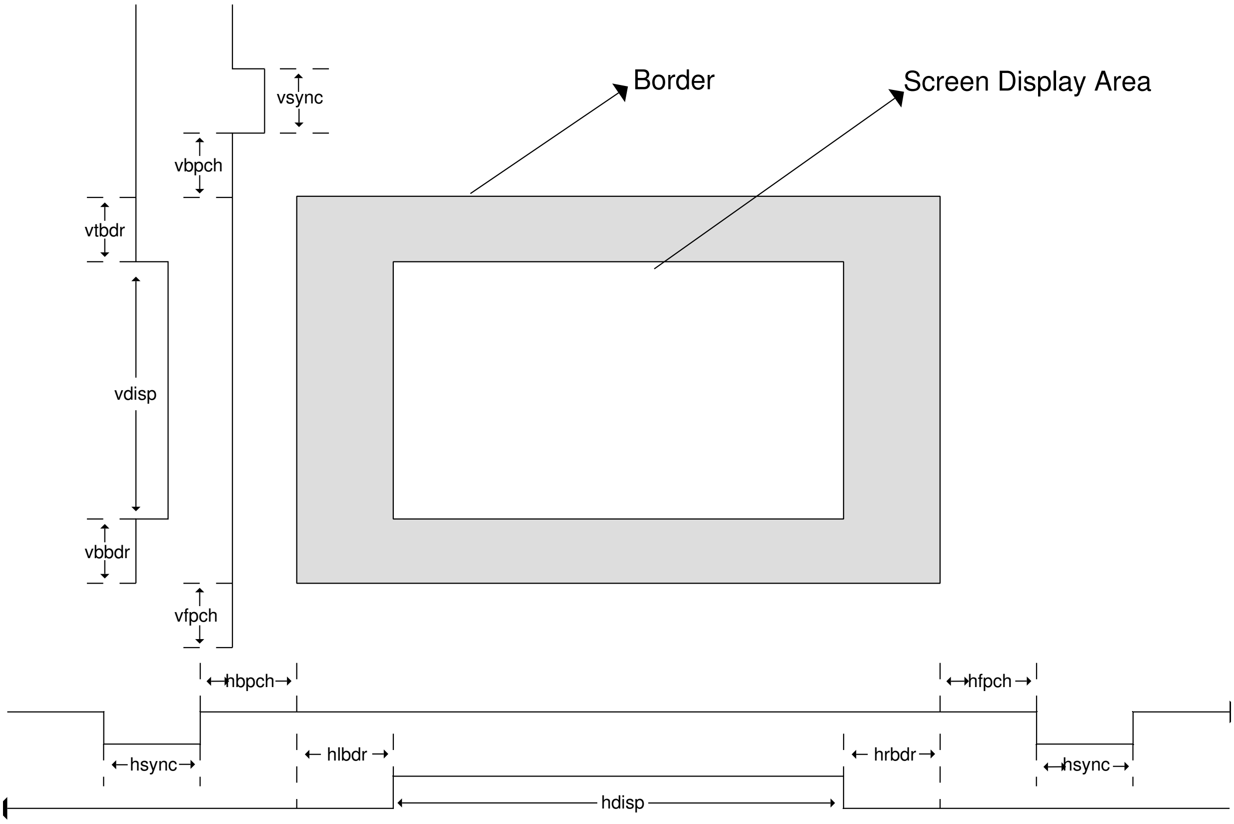
mode_name:	is a textual name for the mode that will be used in the display manager's mode menu. It is possible to prevent defined screen modes from appearing in the modes menu by simply leaving this field blank. Mode names are limited to 19 characters in length and may contain space characters.
x-resolution:	is the number of pixels displayed across the screen
y-resolution:	is the number of rasters displayed vertically (pixels)
hsync:	is the width of the horizontal sync pulse
hbpch:	is the width of the horizontal back porch
hlbdr:	is the width of the left border
hdisp:	is the number of pixels displayed horizontally (which is normally the same as the x-resolution)
hrbdr:	is the width of the right border
hfpch:	is the width of the horizontal front porch
vsync:	is the width of the vertical sync pulse
vbpch:	is the width of the vertical back porch
vtbdr:	is the width of the top border
vdisp:	is the number of rasters displayed vertically (pixels)
vbbdr:	is the width of the bottom border
vfpch:	is the width of the vertical front porch
pixel_rate:	is the pixel rate in kHz
sync_polarities:	is a number indicating what kind of sync signals are required. The kinds of sync signal are as follows:

0	hsync normal, vsync normal
1	hsync inverted, vsync normal
2	hsync normal, vsync inverted
3	hsync inverted, vsync inverted

All values on the h_timings line are in units of pixels, and all values on the v_timings line are in units of raster lines.

Note: VIDC20 imposes restrictions on these parameters. In particular, all the horizontal timing values must be in multiples of 2, and the horizontal total (hsync + hbpch + hlbdr + hdisp + hrbdr + hfpch) must be a multiple of 4.

The diagram below gives a graphical representation of this information.



Glossary of terms

Before describing in detail how these parameters can be used to define a new screen mode, it is necessary to understand some of the conventions that will be used in this application note.

Video Bandwidth

Video Bandwidth is the term used to describe the amount of video information that a Risc PC can process over a specified time period. Typically, video bandwidth will be specified as megabytes per second e.g. a Risc PC fitted with 2MB VRAM has a maximum video bandwidth of 156MB/sec.

Dot Pitch

The dot pitch is the physical spacing of the phosphor dots that a monitor uses to generate a screen display. The smaller the dot pitch, the clearer the picture. Some high resolution screen modes may appear blurred if the dot pitch is not small enough to cope with the size of the pixels being generated by the computer.

Line Rate (Horizontal frequency)

A monitor's line rate defines the speed at which a monitor can scan one horizontal line. The line rate is normally specified as a range in kHz i.e. the AKF60 has a line rate range of 30-50kHz.

Frame Rate (Vertical frequency)

The frame rate is the speed at which the monitor can refresh the screen. The frame rate is normally specified as a range in Hz i.e. the AKF60 has a frame rate range of 40-90Hz.

Pixel Depth

Pixel depth dictates the number of colours that can be displayed on the screen. Pixel depth is measured in bits per pixel (bpp). The following table describes how bits per pixel relates to the number of colours that will be displayed;

Bits per pixel	Number of colours
1 bpp	2
2 bpp	4
4 bpp	16
8 bpp	256
16 bpp	32,000
32 bpp	16 Million

Limiting Factors

Before creating a new screen mode or a new monitor definition file using the !MakeModes application, you should be fully aware of the factors limiting the display of a screen mode and the interrelationship of the variable paramaters.

The following describes these interrelationships and offers guidance on the limits for the screen mode definition. As values are changed, the MakeModes application automatically checks that the mode will be displayable, if it is not, MakeModes will inform you. However, much time will be saved when attempting to create new modes if you understand and work within the limits imposed rather than using a 'trial and error' method.

Listed below are the three main limiting factors which are discussed in this document.

- Monitor Limitations
- Memory Limitations
- Bandwidth Limitations

Monitor Limitations

The screen mode must not exceed the monitor's line rate (horizontal frequency), frame rate (vertical frequency) or its maximum pixel rate. A monitors line and frame rate ranges can normally be found in its accompanying documentation. Please see the MakeModes manual for information on how to enter this information.

The Pixel rate is one of the principal variables that you will use in the MakeModes application. It can be used to increase or decrease a modes frame rate. Because a modes **Line rate** is directly affected by its **Frame rate**, altering the **Pixel rate** will change this value as well. The Pixel rate is calculated from:

```
Pixel Rate = sum(h_timings) * sum(v_timings) * proposed frame rate
```

or

$$Pixel\ Rate = \sum[h\_timings] \times \sum[v\_timings] \times frame\ rate$$

Frame and line rates can be calulated from:

```
Frame Rate = pixel_rate / (sum(h_timings) * sum(v_timings))
```

or

$$frame\ rate = \frac{pixel\_rate}{\sum[h\_timings] \times \sum[v\_timings]}$$

```
Line Rate = sum(v_timings) * frame_rate
```

or

$$Line\ rate = \sum[v\_timings] \times frame\_rate$$

Memory / Bandwidth Limitations

The Risc PC can have up to three different screen memory configurations, no VRAM (DRAM only), 1MB VRAM or 2MB VRAM.

With no VRAM fitted the Risc PC will be forced to use DRAM which has a slower access time than dedicated Video RAM. This greatly increases the amount of time spent by the processor updating the screen and therefore limits the amount of memory that can be used as screen RAM. This limitation in turn limits the maximum resolution and pixel depth that can be used. On a machine with 1MB VRAM, the maximum amount of screen memory that the system can process is 80MB/sec, with 2MB of VRAM, this figure doubles giving a maximum video bandwidth of 160MB/sec. Without VRAM the maximum video bandwidth is 40MB/sec. In order to provide a safety margin, the bandwidth limit file stored in the !Boot directory on the Risc PC hard disc sets the maximum bandwidths to 38MB/sec, 76MB/sec and 152MB/sec respectively.

Is is important to be aware of both the memory and bandwidth calculations as it is possible to define a mode that fits within the available video RAM but exceeds the machines maximum video bandwidth. The MakeModes application will warn you if a proposed screen mode will exceed either of these limitations.

The following table shows an example of the screen modes and colour combinations (pixel depths) that can be used with the three different VRAM options.

0MB VRAM Fitted

	B/W	16	256	32K	16M
480 x 352	✔	✔	✔	✔	X
800 x 600	✔	✔	✔	X	X
1024 x 768	✔	✔	X	X	X

1MB VRAM Fitted

	B/W	16	256	32K	16M
480 x 352	✔	✔	✔	✔	✔
800 x 600	✔	✔	✔	✔	X
1024 x 768	✔	✔	✔	X	X

2MB VRAM Fitted

	B/W	16	256	32K	16M
480 x 352	✔	✔	✔	✔	✔
800 x 600	✔	✔	✔	✔	✔
1024 x 768	✔	✔	✔	✔	X

Calculating required bandwidth for a screen mode

The bandwidth used by a screen mode increases according to the number of colours being used. The calculations necessary to find the bandwidth for each *bpp* mode are listed below;

Bits per pixel	Calculation used
1 *bpp*	**Video Bandwidth = (pixel_rate / 1000000) / 8**
2 *bpp*	**Video Bandwidth = (pixel_rate / 1000000) / 4**
4 *bpp*	**Video Bandwidth = (pixel_rate / 1000000) / 2**
8 *bpp*	**Video Bandwidth = (pixel_rate / 1000000)**
16 *bpp*	**Video Bandwidth = (pixel_rate / 1000000) * 2**
32 *bpp*	**Video Bandwidth = (pixel_rate / 1000000) * 4**

These calculations will give a result in MB/sec.

Calculating memory requirements for a screen modes

Besides bandwidth limitations, another factor that one must also consider when creating a new mode is the amount of screen memory that will be needed. To work out how much memory a screen mode will need you must first find out how many pixels will be displayed in total. Multiplying the x_resolution by the y_resolution will give this figure.

pixel_total = x_resolution * y_resolution

This total is then used in conjunction with the number of bits per pixel (*bpp*) to calculate the amount of memory required.

Bits per pixel	Calculation used
1 *bpp*	**VRAM = pixel_total** */8*
2 *bpp*	**VRAM = pixel_total** */4*
4 *bpp*	**VRAM = pixel_total** */2*
8 *bpp*	**VRAM = pixel_total**
16 *bpp*	**VRAM = pixel_total** * 2
32 *bpp*	**VRAM = pixel_total** * 4

Examples

The following table gives an example of how much memory is required for some standard screen modes at various pixel depths.

		B / W	4 Greys	16 Cols	256 Cols	32000	16 Million
Resolution	480 x 352	20K	41K	82K	165K	330K	660K
	800 x 600	59K	117K	234K	469K	938K	1876K
	1024 x 768	96K	192K	384K	768K	1536K	3072K

As can be seen from the table above, not all screen modes can be displayed at every pixel depth e.g. only machines with 2MB VRAM would be able to display 800 x 600 at 16 Million colours. Machines fitted with only 1MB VRAM could only display those modes that require 1024K or less.

What the horizontal and vertical timings mean

The **horizontal sync width** (hsync) value is the time, in units of pixels of the horizontal sync pulse. If the hsync pulse is not wide enough the monitor will be unable to sync correctly.

The **horizontal back porch** (hbpch) and and **horizontal front porch** (hfpch) values define the time, in units of pixels, from the end of the hsync pulse to the start of the **horizontal left border** (hlbdr) and the end of the **horizontal right border** and to the end of the horizontal scan line respectively. Amongst other things the hsync+hbpch time period is used by the VIDC20 to switch between cursor and video data. If the combined time period is not long enough, the screen display will be corrupted as the VIDC20 will be unable to fetch video data before the screen display starts.

The **horizontal left border** and **horizontal right border** values define the time period, in units of pixels, for the left and right screen borders. The horizontal left border and horizontal back porch values can be altered to position the picture correctly.

The **horizontal display** (hdisp) value is the horizontal screen resolution i.e the number of pixels displayed across the screen.

The **vertical sync** (vsync) value is the width, in units of raster, of the sync width pulse. If this pulse is not wide enough, the monitor will be unable to sync to the signal.

The **vertical porches** (vbpch, vfpch), **vertical borders** (vtbdr, vbbdr) are the vertical equivalents of the horizontal values but are all measured in units of raster.