

- ***ELSA ERAZOR™ II***
- ***ELSA VICTORY Erazor™ LT***

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Aachen, September 1998

# Preface

Thank you for placing your trust in this ELSA product.

To make sure that you have undiluted fun with your ELSA board, we insist on the highest quality requirements in manufacturing and stringent quality control to ensure our high product standards and consistent product quality.

## About this Manual

This manual provides all the information you will need to get the best out of your ELSA graphics board. The accompanying ELSA utilities are described, and you will find detailed information about 3D and video.

## Changes to this Manual

ELSA products are subject to continual further development. It is therefore possible that the printed documentation does not always correspond to the latest release. However, information about the latest changes is always to be found in the README files on the ELSA CD.



*If you have questions to the topics covered in this manual or require additional help, our online services are at your disposal around the clock. The complete range of support and services provided by ELSA can be found in the "Advice and Help" chapter.*

*In very urgent cases the ELSA Support hotline can be reached under the following number:*

**+49-241-606-6131**



**Before you continue**

*Installation of the ELSA ERAZOR II and ELSA VICTORY Erazor LT and installation of the associated drivers are described in the Installation Guide. Please read this information first before you start reading this manual.*

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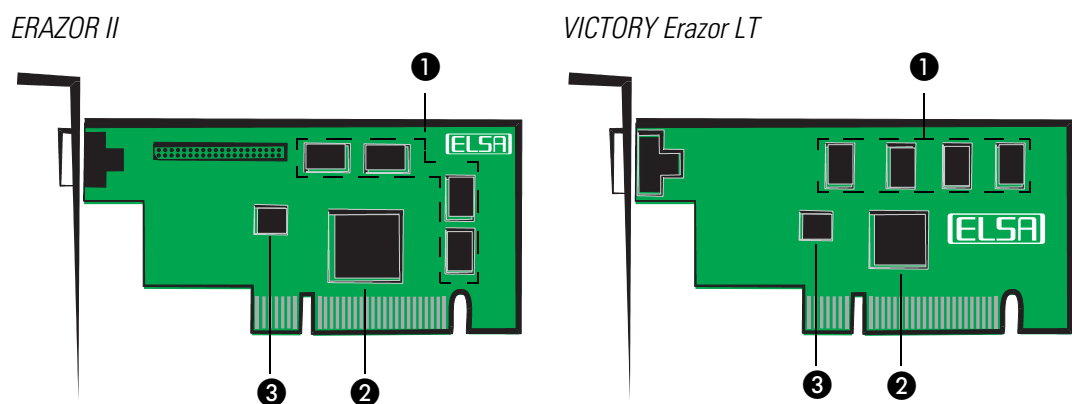
# Introduction

“Reading the manual is a waste of time.” A prejudice you are proving to be wrong right now by reading this manual. And rightly so. In this case, it is really worth the effort. Because the *ELSA ERAZOR II* and *ELSA VICTORY Erazor LT* has some smart features that are only described here in the manual.

So only those who read the manual will truly be taken with this card. We'll make it as short and easy as we can—promise.

## A Look at the *ERAZOR II* and *VICTORY Erazor LT*

Just what are you sticking into your computer? The boards are getting smaller, but at the same time more powerful. In the diagram and legend below, we explain the functions of the board's chief components



- ❶ The video memory. This checks out which image is being displayed on the screen and thinks one step ahead. Only in this way can rapid graphics generation in the graphics board be ensured.
- ❷ The graphics processor. The heart of the board. The RAMDAC is integrated in it. The monitor is not able to process the digital signals from the graphics processor directly. The RAMDAC comes in here and translates the digital signals into analog signals. All this at a clock speed of 250 MHz.
- ❸ The BIOS. One of its tasks is to ensure that the system recognizes the graphics board.



*You can find technical details about the graphics boards on page 21.*

## Highlights of *the Erazor Graphics Boards*

- **Wide data flow** – True 128 bit graphics acceleration for Windows NT, Windows 95 and Windows 98
- **A giant with potential for growth** – the performance of the RIVA 128ZX grows with processor power. This can be summed up in a phrase: “The more powerful the CPU, the more powerful the *Erazor*”.
- **A games arcade on your living room** – arcade quality 3D graphics with high-speed direct 3D support
- **Fast video** – High quality, multiple filtered MPEG and AVI play.
- **When things get tight** – Textures are dynamically stored in the computer's working memory
- **Superfast** – DOS with VBE 3.0 BIOS
- **24-hour access** – To ELSA Support in the ELSA LocalWeb and Internet-WWW
- **Guaranteed** – 6 years warranty on the *ELSA ERAZOR II and ELSA VICTORY Erazor LT*
- **Protected** – The *ELSA ERAZOR II and ELSA VICTORY Erazor LT* meet CE requirements.

## What Hardware Do I Need?

- **Computer:** The *ELSA ERAZOR II and ELSA VICTORY Erazor LT* only really come to life if your computer has a Pentium 166 or compatible processor or even better. Less muscular processors will not get the best out of the board.
- **Bus:** The *ELSA ERAZOR II and ELSA VICTORY Erazor LT* can be had in AGP versions. Your computer must have an AGP bus.
- **Monitor:** The *ELSA ERAZOR II and ELSA VICTORY Erazor LT* works with the standard IBM VGA compatible horizontal scan frequency of 31.5 kHz while booting and in DOS operation.

## What's In the Box?

You will notice if your graphics board is missing. But you need to check that the box contained all of the following:

- Graphics board
- Documentation: Installation Guide and electronic manual on CD
- CD-ROM with installation and driver software and utilities

If any part is missing please contact your dealer. ELSA reserves the right to vary the products supplied without prior notice.



## CE Conformity and FCC Radiation Standard

### CE

This equipment has been tested and found to comply with the limits of the European Council Directive on the approximation of the laws of the member states relating to electromagnetic compatibility (89/336/EEC) according to EN 55022 class B.

### FCC

This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the Federal Communications Commission (FCC) Rules. The testing of this compliance involved the following procedures:

- Declaration of Conformity (→page 24)

### CE and FCC

These limits are designed to provide reasonable protection against radio frequency interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy. It may interfere with to radio communications if not installed and used in accordance with the instructions. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception (this can be determined by turning this equipment off and on), the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between this equipment and the receiver.
- Connect the equipment to an outlet on a circuit other than that to which the receiver is connected.
- Consult your dealer or an experienced radio/TV technician.
- Caution: To comply with the limits for an FCC Class B computing device, always use a shielded signal cable.



*Caution to the user: The Federal Communications Commission warns the user that changes or modifications to the unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*



# After Installing the Drivers

You will have completed the most important steps once the Installation Guide has piloted you safely through the hazards of driver installation. Your operating system knows about the *Erazor*, the ELSA drivers are installed and ...

## It's Time to Get Moving!

We have a tip for you at this point: A few minutes' patience will pay for themselves. Take a few moments' time to optimize your system settings. Your eyes will thank you for it and you will certainly enjoy playing games and working on your computer much more.

In this chapter you will learn:

- What is the maximum resolution I can get from my system?
- What color depth should I use?
- How frequently should the monitor redraw itself?

This chapter is divided up into operating systems to allow us to answer these questions for you as simply as possible. Turn straight to the heading for your operating system. You will find everything you need there. The software you need will be on the *WINNERware CD* – unless it is already included in the operating system.

## What is Possible?

The table below shows the maximum possible resolutions for the ELSA graphics board. Note that these resolutions cannot be achieved under all operating conditions.

### **ERAZOR II**

Color depth:	Refresh rate (Hz) / Z-Buffer, Double Buffering					
	256 Colors		HighColor		TrueColor	
	8MB	16MB	8MB	16MB	8MB	16MB
1600 x 1200	85/–	85/–	85/✓	85/✓	85/✓	85/✓
1280 x 1024	120/–	120/–	120/✓	120/✓	120/✓	120/✓
1152 x 864	120/–	120/–	120/✓	120/✓	120/✓	120/✓
1024 x 768	120/–	120/–	120/✓	120/✓	120/✓	120/✓
960 x 720	120/–	120/–	120/✓	120/✓	120/✓	120/✓
800 x 600	120/–	120/–	120/✓	120/✓	120/✓	120/✓
640 x 480	120/–	120/–	120/✓	120/✓	120/✓	120/✓

*HighColor* = 65536 colors, *TrueColor* = 16.7 million colors

**VICTORY Erazor LT**

Color depth:	Refresh rate (Hz) / Z-Buffer, Double Buffering		
	256 Colors	HighColor	TrueColor
1600 x 1200	85/–	85/–	–/–
1280 x 1024	100/–	100/–	75/–
1152 x 864	120/–	120/–	120/–
1024 x 768	120/–	120/–	120/–
800 x 600	120/✓	120/–	120/–

*HighColor = 65.536 colors, TrueColor = 16,7 million colors*

**What Makes Sense?**

There are some basic ground rules for you to follow when setting up your graphics system. On the one hand, there are the ergonomic guide values although nowadays these are met by most systems, and on the other hand there are limitations inherent in your system, e.g. your monitor. The question of whether your applications need to run using high color depth – perhaps even using TrueColor – is also important. This is an important condition in many DTP workstations, for instance. A color depth of 64K is recommended for games and “normal” Windows applications.

**“More pixels means more fun”**

This idea is widely held, but is not always true. The general rule is that a refresh rate of 73 Hz meets the minimum recommended ergonomic requirements. The resolution to be selected is, furthermore, dependent on the capabilities of your monitor. The table below is a guide to the resolutions you might select:

Monitor size	Typical image size	Minimum recommended resolution	Maximum recommended resolution	Ergonomic resolution
17"	15.5" - 16"	800 x 600	1024 x 768	1024 x 768
19"	17.5" - 18.1"	1024 x 768	1280 x 1024	1152 x 864
20"/21"	19" - 20"	1024 x 768	1600 x 1200	1280 x 1024
24"	21" - 22"	1600 x 1000	1920 x 1200	1600 x 1000

## Changing the resolution

You set the resolution of your graphics board in the Control Panel under Windows.



*The ELSA graphics card is normally supplied with software on a CD-ROM. You will find all the utilities described in this manual on the WINNERware CD – unless they are a component of the operating system.*

## Windows 95 and Windows 98



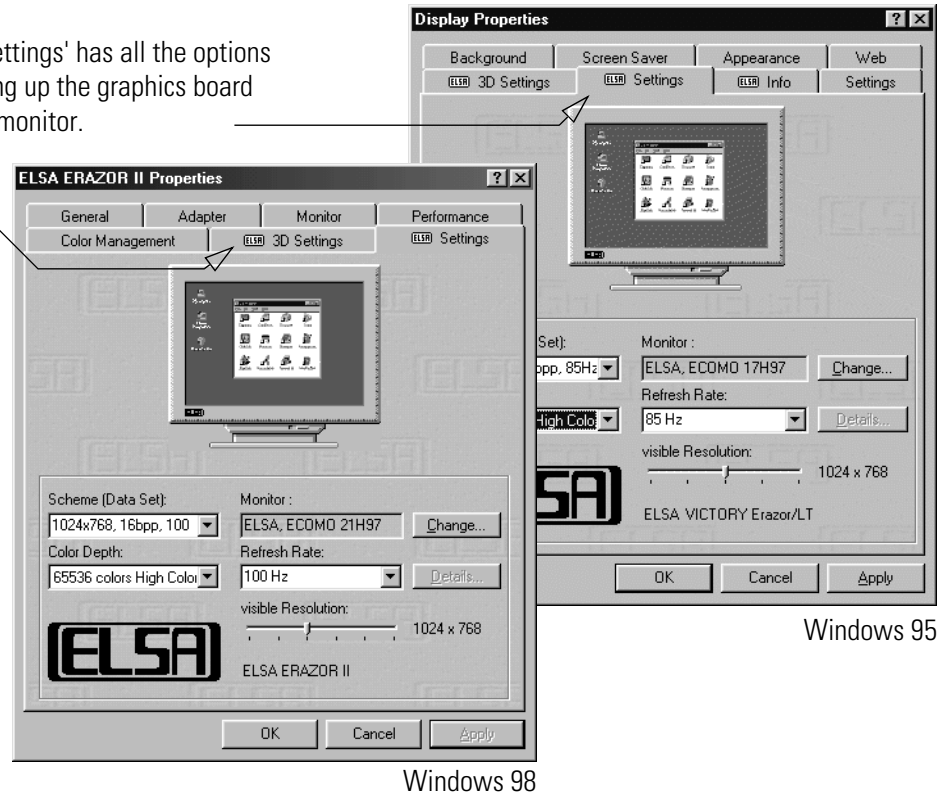
*If you have installed the OpenGL driver, you should be aware that this version of OpenGL only supports games which are suited. A sleek and minimal range of functions guarantees a rapid games performance.*

The '**ELSA** Settings' are automatically integrated into the Control Panel during the installation of the *WINman Suite*. You can use these Settings to tweak your graphics system for the best performance. The '**ELSA** Settings' provide some great features. Once you have specified the graphics board model and the monitor data, the program will automatically detect which settings are possible and which are not. This means, for instance, that it is impossible for you to select an incorrect refresh rate which might damage your monitor.

- ① Click on **Start**, then select **Settings** ► **Control Panel**.
- ② You will find the **Display** program in the Control Panel. When you start this program, you are shown a dialog box where you can modified the display settings.

- ③ Here you should click on the '**ELSA** Settings' tab.

'**ELSA** Settings' has all the options for setting up the graphics board for your monitor.



Windows 95

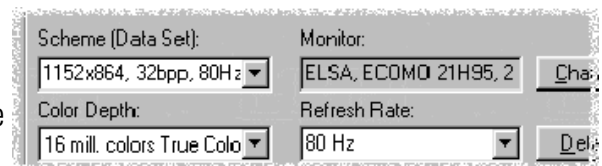
Windows 98



Under Windows 98, you can reach the '**ELSA** Settings' by selecting the Settings card and then clicking on the **Advanced...**

It is important to carry out the following settings or checks step by step:

- the color depth
- the monitor type
- the resolution of the monitor image (Scheme, Data Set) and
- the refresh rate.



### Choosing the monitor

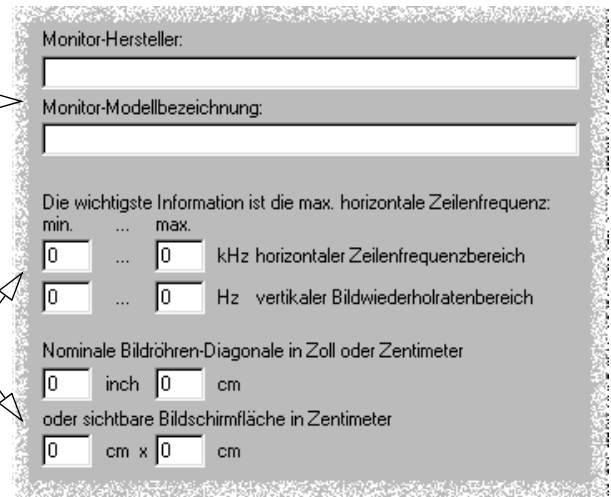
If your monitor supports DDC, the preset values will be displayed under 'Scheme'. If this is not the case, click on **Change...** to call up the database of monitor types. You will be presented with a list of monitor manufacturers and monitor models. If your manufacturer is present, click on the entry and then select your model. If your monitor is not listed, there are two options. One option is to select the "\_Standard monitor" from the list of manufacturers and then select the resolution you wish to work with.

A second option requires information about the technical specifications for your monitor. Consult your monitor manual to ensure that you have the correct information. Click on **Change...** in the 'Monitor type database' window. In addition to the information regard-

ing the monitor manufacturer, and the model designation, you will have to enter the frequency ranges for the horizontal and vertical scan frequencies and specify the diagonal size of your monitor.

If your monitor type is not listed in the monitors database you can enter the monitor manufacturer and model type here.

The vertical and horizontal frequency ranges and the diagonal size of the screen are the important settings.



The screenshot shows a dialog box for configuring a monitor. It has two text input fields at the top: "Monitor-Hersteller:" and "Monitor-Modellbezeichnung:". Below these are two rows of frequency settings. The first row is for horizontal frequency, with labels "min.", "...", and "max." above input boxes, followed by "kHz horizontaler Zeilenfrequenzbereich". The second row is for vertical frequency, with labels "min.", "...", and "max." above input boxes, followed by "Hz vertikaler Bildwiederholratenbereich". Below the frequency settings are two rows for screen size. The first row is for diagonal size, with labels "Nominale Bildröhren-Diagonale in Zoll oder Zentimeter" above input boxes for "inch" and "cm". The second row is for visible area, with labels "oder sichtbare Bildschirmfläche in Zentimeter" above input boxes for "cm x" and "cm".

*Check your entries for the image frequencies carefully, as otherwise you might damage your monitor. Look these up in your monitor manual or consult the monitor manufacturer.*

## Windows NT 4.0

The settings for the graphics driver are included in the Control Panel under Windows NT 4.0. Use the command sequence

**Start ► Settings ► Control Panel**

to call the dialog window where you should find the icon for **Display**. Double click on this symbol to open the window with its various tabs. Click on the 'Settings' tab.

You can select the possible settings for 'Color palette', 'Font size', 'Resolution' and 'Display frequency' from this dialog box. The available selection is determined by the ELSA driver you have installed. You should always check the configuration you have selected by clicking on the **Test** button.



*You will find further information on how to customize your graphics settings under Windows NT 4.0 in your system manual.*



# Useful Stuff and More

You have received a CD with your *ELSA ERAZOR II and ELSA VICTORY Erazor LT*. On the *WINNERware* CD you will find all the drivers you will need for the use of the *ELSA ERAZOR II and ELSA VICTORY Erazor LT* under various operating systems and the tools you can use to exploit all the features on the graphics board.

On the following pages we will introduce the tools and their uses.

## The Multimedia Player

Until now, a variety of programs for the playback of CDs, videos and other media was available under Multimedia in the Accessories folder of the Windows start menu. These have now been succeeded by the Microsoft Multimedia Player. It handles the most common multimedia formats, all under one common user interface—regardless of whether the data is coming from the Internet or the local hard disk. The Multimedia Player is responsible for the playback of RealAudio and RealVideo, as well as WAV, AVI and Quicktime files.



Video playback or Internet live radio: The Microsoft Multimedia Player handles all common multimedia formats.



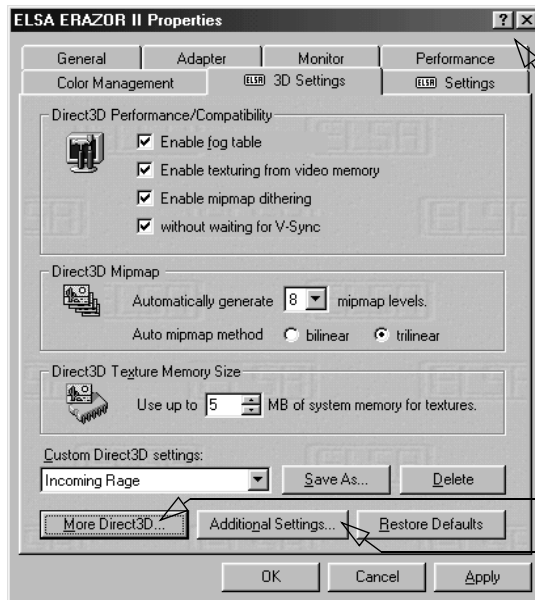
After the installation, the file extensions of media files are permanently associated with the Multimedia Player. You can thus double-click the media files in the Windows Explorer or My Computer folder to conveniently launch the Player and start the playback.

The use of the Multimedia Player is intuitive, and it includes a comprehensive help function to clarify questions or solve problems while working with the program.



## Fine-Tuning for Performance Freaks

After installing the ELSA graphics drivers under Windows 95 and Windows 98 you will find a new tab in the 'Display Properties': The '**ELSA** 3D Settings'.



The question mark provides the answers! Click on this symbol and then on the area of the dialog about which you want more information.

There's more!

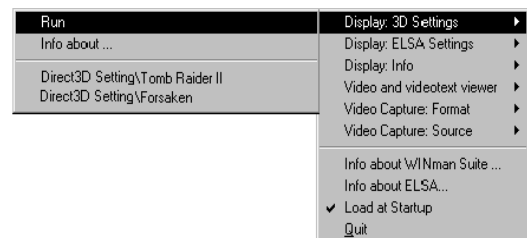
Click on this button for additional dialog windows.



*Because Windows 98 allows the operation of multiple graphics boards, the 3D Settings for the Erazor are to be found in another location. Under 'Display Properties' select in turn: 'Settings' ► **Advanced...** ► '**ELSA** 3D Settings'.*

These settings let you set up the optimal games performance on your system. In most cases you don't need to adjust anything. Once in a while if you see display errors on screen or if there are problems with the speed, you can adjust the Direct3D or OpenGL settings. The settings which are optimal for any game can saved under an identifiable name and quickly recalled without having to restart your system.

Once saved, the settings can be easily recalled: the individual 3D configurations for your games can be found in the *ELSA WINman Suite*.



Experimentation pays! Give your combatant a little extra "zip" and optimize his chances against the competition. If the descriptions here are too cryptic, just take a look at the glossary in this manual or use the comprehensive help system. Simply click on the question mark at the top right-hand corner of the dialog window, and then click on the item in question. If you accidentally dump your system into the crawler-lane, just click on the emergency button **Restore Defaults**. The standard settings will be called into action.

# All about graphics

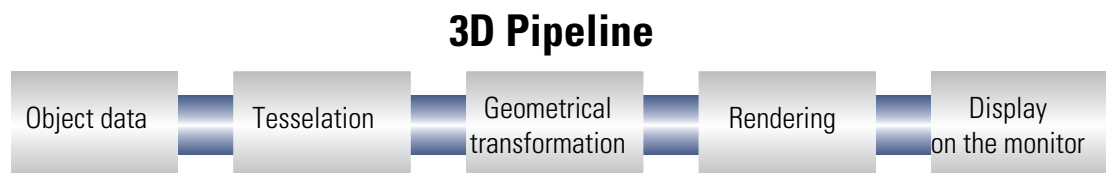
This is the chapter where we really get stuck in. Anyone who wants to know more about graphics—especially in connection with the *ELSA ERAZOR II* and *ELSA VICTORY Erazor LT*—will find a whole load of technical stuff right here.

## 3D Graphics Representation

Today it is considered de rigeur to know all about 3D. Your curiosity will be aroused as soon as you experience the first visual wizardry generated by your new graphics board. Two features of the 3D display will leap out at you: it's both realistic and fast. The amount of work required here is known only to the processor, but we will describe it in detail to you below.

### The 3D Pipeline

What actually happens when a monitor displays a 3D object? The data describing the 3D object are passed through what is known as the 3D pipeline, in which the mathematical calculations for its representation in space and perspective on the monitor are carried out. What happens in detail?



#### Start: The object data

The pipeline starts at the object. The object description is made up of the data (points).

#### Tessellation

In the first step, the object is broken down into a number of polygons or triangles. The vertices of the triangles are described by coordinate points (x, y and z) with the 'z' value containing the depth information. Depending on the representation, these vertices also contain information concerning the material and texture. The volume of data to be processed increases enormously because of this conversion of the image information.

## Geometrical transformation

This part of the 3D pipeline is very processor-intensive, as all the calculations for the 3D scene are carried out at this stage. Described in simple terms, it comprises the following steps:

- **Illumination**—The illumination of the scene by different light sources is calculated.
- **Transformation**—In transformation, the objects are aligned in perspective as seen from the observer's point of view.
- **Back face culling**—This process computes hidden surfaces resulting from the observation perspective chosen. Any object having an invisible front surface is omitted.
- **3D clipping**—In this process, each polygon is checked to determine whether it is partially or fully invisible. The invisible faces or parts of objects will be removed.
- **Scaling on the screen** — The above steps are now calculated for three-dimensional space using normalized coordinates. The on-screen image coordinates will only now be computed.

## Rendering

At this stage, the 3D scene is filled with color shades and textures are applied. Different processes and methods are also applied here.

- **Texture mapping** — At this stage, the 3D object undergoes a sort of "face lift". The materials and textures are assigned. Different methods are used here to make the textures appear realistic, even when enlarged or reduced. As a first step, the textures are computed:
  - *Point sampling* is the simplest method. A pixel-by-pixel comparison is made between the texture template and the surface to be filled. This method leads to a very coarse representation, especially when enlarged.
  - In *linear mapping*, a new color value is interpolated from the adjacent pixels (or texels) of a texture. This gives better results than point sampling, as the hard boundary between the coarse pixels is blurred.
  - The *MIP mapping* method stores a large number of enlargement stages for the texture. The depth information of a primitive is then used to determine which enlargement stages of the texture will be used in drawing. Normal textures seldom contain more than 256 colors. The first 15 bits of a 16-bit wide color representation are reserved for the colors (5/5/5 > R/G/B). Information concerning the transparency of the texture is carried in the alpha channel. The last bit is reserved for this information. Finally, a distinction is made in MIP mapping between *bilinear* and *trilinear filtering*. Bilinear filtering interpolates between two pixels of two textures, trilinear filtering interpolates between four pixels for each of two textures.

- *Bump mapping* introduces a new dimension. Relief or raised textures can only be generated with the other methods in two dimensions using light and shadow effects. In bump mapping, the texture is additionally assigned height information, which allows very realistic three-dimensional effects to be created.

The staircase effect is corrected by *anti-aliasing*. This is either done by interpolating mixed pixels, in which a new color value is computed from two adjacent color values, or by using transparent pixels of the same color which are overlaid over adjacent pixels.

- **Shading** – Shading takes account of the effects created by different light sources on the 3D object and provide for a very realistic overall impression. Here, too, there are different methods which are more or less processor-intensive:
  - *Flat shading* assigns a color value to each polygon. This results in a mosaic-like, jagged representation, which demands only a short processing time.
  - In *Gouraud shading*, all the vertices of the polygons are assigned a color value. The remaining pixel information for the polygon is interpolated. This method gives a very gentle color transition, even with fewer polygons than are required for flat shading.
  - The *Phong shading* method additionally takes a normal vector of reflectivity into consideration when interpolating. An even more realistic impression is generated by the representation of reflections and mirror images.
  - Certain applications use ray tracing methods. This is a very computer-intensive and time-consuming process in which each individual pixel and its reflection in 3D space is calculated.

- **The frame buffer**

The finished image will not be written to the *frame buffer* until this complex sequence of steps is completed. The frame buffer is made up of front and back buffer. The back buffer acts as a buffer page, in which the next image to be displayed is built up. This prevents the process of image drawing being visible. The duplicate storage method is also known as double buffering.

### **Flipping: Display on the monitor**

The content of the *front buffer* is displayed on the monitor. When the drawing process in the back buffer is completed, this image is then passed to the front buffer in a process known as *flipping*.

The next image will only ever be displayed once the image drawing process in the back buffer is completed. This procedure should be repeated at least 20 times a second to give a smooth representation of 3D scenarios. In this context, we speak of frames per second (fps), a very important value for 3D applications. A cinema film runs at 24 fps.

## 3D Interfaces

Software interfaces, including 3D interfaces, are known as APIs (Application Program Interface). The question is what are these interfaces used for, and how do they work.

In simple terms: They make developers' work easier. The methods by which the various interfaces function, are comparable: In the past it was necessary to address the various hardware components directly in programming if you wanted to exploit their capabilities to the full. The APIs are a kind of translator operating between the hardware and the software.

The specification of standard definitions was the precondition for the proper function of these translation routines. These definitions are implemented by the hardware manufacturers during development and optimized for the hardware concerned. Developers can implement complex procedures relatively easily by using these definitions. They can use a uniform command set when programming and do not need to know the characteristics specific to the hardware.

### What APIs Are Available?

There are a good dozen more or less commonly found 3D APIs. However, in recent years, two formats have established themselves as the favorites: Direct 3D and OpenGL. ELSA graphics boards support these commonly found 3D interfaces. The functional differences between the interfaces are slight, as is shown by the table below. The decisive questions for the user concern extensibility, flexibility and possible portability to existing applications.

Function	Direct 3D	OpenGL
Alpha blending	■	■
Texture mapping	■	■
MIP mapping	■	■
Video motion mapping	■	□
Fogging	■	■
Anti-aliasing filter	■	■
Flat shading	■	■
Gouraud shading	■	■
Phong shading	□	□
Stencil buffer	□	■

### Direct 3D

As a development of Mode X and DirectDraw under Windows 3.1x, Direct 3D is a branch of the DirectX multimedia family which was developed directly for Windows 95 to accel-

erate the slow 3D display characteristics of the operating system. Direct 3D is based on Microsoft's Common Object Model (COM), which is also used as the foundation to OLE technology (Object Linking and Embedding). Direct 3D cooperates with Direct Draw in two-dimensional display. A typical situation would be, for instance, rendering a 3D object while Direct Draw is placing a two-dimensional background bitmap. Microsoft claims to have corrected some of the weaknesses of the old version in the most recent version 5.0.

### **Immediate Mode and Retained Mode**

As can be assumed from the two terms, immediate mode is a programming mode that is close to the hardware. Retained mode, on the other hand, is a programming mode that is largely predefined through an API interface. What does this mean in detail? Looking at the two systems hierarchically, the immediate mode is also known as the low-level mode. The programming interface level is close to the hardware level and permits the programmer direct access to special functions in the hardware component concerned. The retained mode (high-level mode) makes it possible, for example, to load a defined 3D object with textures into a Windows application. Here it can be manipulated and moved using simple API commands. Translation takes place in real time, without the need to know the technical structure of the object.

*For further information see the Internet WWW site <http://www.microsoft.com>*



### **OpenGL**

Following its success in gaining a good reputation amongst professionals using CAD/CAM programs, OpenGL is now increasingly penetrating the PC market. OpenGL is platform-independent and makes a distinction between immediate and display list modes. A display list stores specific sequences that can be recalled again later. The object descriptions can then be taken directly from the list, resulting in very high performance. However, if objects need to be manipulated frequently, the display list will have to be generated again from new. In this case, the speed advantage is lost. OpenGL provides a wide range of graphics features, from rendering a simple geometric point, line, or filled polygon, to the most sophisticated representations of curved surfaces with lighting and texture mapping. The some 330 routines of OpenGL provide software developers access to these graphics capabilities:

*For further information see the Internet WWW site <http://www.sgi.com>*



## Color Palettes, TrueColor and Gray Scales

Common graphics modes are listed in the following table. Not all graphics modes are available on the *ELSA ERAZOR II* and *ELSA VICTORY Erazor LT* boards.

Graphics mode	Colors			Max. gray levels
	bpp	bpg	(from palette)	
VGA 0x12	4	6+6+6	16 of 262,144	16
VGA 0x13	8	6+6+6	256 of 262,144	64
Standard	8	6+6+6	256 of 262,144	64
	8	6+6+6	256 of 16.7 million	256
HighColor	15	5+5+5	32,768	32
	16	6+6+4	65,536	16
	16	5+6+5	65,536	32
TrueColor	24	8+8+8	16.7 million	256

(*bpp = bits per pixel; bpg = bits per gun*)

### VGA

In VGA graphics adapters, the digital color information stored in the video memory (4 bits for 16 colors or 8 bits for 256 colors) is converted into a digital 18-bit value in the graphics adapter in a CLUT (ColorLookUpTable). The 3 x 6 bits are converted separately for R/G/B (red/green/blue) in the RAMDAC (D/A converter) and transferred to the monitor as analog signals on just three lines (plus sync lines). The original color values are converted into completely different values by means of a translation table. The value stored in the video memory is thus not a color value, but only a pointer to a table in which the actual color value is found. The advantage of this method: Only 8 bits need to be stored for each pixel, although the color values are 18 bits wide; the disadvantage: Only 256 colors can be displayed simultaneously from a palette of 262,144 possible colors.

### DirectColor

The situation is different in the case of DirectColor (TrueColor, RealColor and HighColor). In this case, the value stored in the video memory is not translated but is passed directly to the D/A converter. This means that the full color information must be saved for each pixel. The meanings of the terms RealColor, TrueColor, and HighColor can be confused, as they are not always used unambiguously.

### HighColor and RealColor

HighColor and RealColor usually describe a 15 or 16-bit wide graphics mode, while TrueColor should only be used for the more professional 24-bit mode (or 32-bit) mode.

15 bits provide 5 bits each for the red, green and blue values, resulting in 32 levels per RGB component and thus 32,768 (= 32 x 32 x 32) different color hues.



The 16-bit graphics modes are organized differently. Most common are (R-G-B) 5-6-5 (e.g. XGA) and 6-6-4 (e.g. i860). 5-6-5 means that 5 bits are used for each of red and blue and 6 bits are used for green. In the case of 6-6-4, 6 bits are used for red and green and 4 bits for blue. Both ways of assigning the bits correspond to the color sensitivity of the human eye: this is highest for green and lowest for blue. 65,536 different colors can be displayed.

### **TrueColor**

The TrueColor mode is more complex, using 24 bits per pixel. Here, 8 bits are available for each color component (256 levels), resulting in 16.7 million different color hues. There are more colors available than pixels on the screen (1.3 million pixels at a resolution of 1280 x 1024 ).

## **VESA DDC (Display Data Channel)**

VESA DDC refers to a serial data channel between the monitor and the graphics board. Required for this is that both components support DDC and that the monitor cable includes the additional DDC line. An extended monitor cable is used so that the can send data about its technical specification, such as the name, model, maximum horizontal frequency, timing definitions etc. or receive commands from the graphics board.

There are various standards; DDC1, DDC2B, and DDC2AB.

### **DDC1**

Only the monitor can send data (unidirectional). A line in the monitor cable is used to send a continuous data stream from the monitor to the graphics board. In the case of a standard IBM VGA compatible 15-pin monitor connector, pin 12 (formerly used as monitor ID bit 1) is used for data transmission, and the Vertical Sync signal of pin 14 is used as transmission clock (VCLK). An EDID data set (Extended Display Identification) of 128 bytes is sent repeatedly, from which the major monitor data can be read in the computer. The computer can then read the most important data, e.g. the monitor size, the extent of DPMS support and a list of the most important VESA monitor timings supported, and some freely definable monitor timings.

### **DDC2B**

The data channel is based on the I2C bus type with the access bus protocol and can be operated in both directions (bidirectionally between monitor and board). In the case of a standard IBM VGA compatible 15-pin monitor connector, pin 12 (formerly used as monitor ID bit 1) is used for data transmission (SDA), and the pin 15 (formerly used as monitor ID bit 3) is used as transmission clock (SCL). The graphics board can request the short EDID information (see DDC1) as well as the more comprehensive VDIF information (VESA Display Identification File).

## **DDC2AB**

With DDC2AB additionally to DDC2B the computer may send commands for controlling the monitor, e.g. for adjusting the screen position or the brightness (similar to ACCESS bus).



*For information on the pin assignment for the VGA D-shell socket 20 in the "Technical Data" chapter .*

# Technical Data

Those of you with a technical bent will find more detailed information regarding the *ELSA ERAZOR II and ELSA VICTORY Erazor LT* in this chapter. All interfaces and their assignments are described in detail.

## Characteristics of the Graphics Boards

	<b>ERAZOR II</b>	<b>VICTORY Erazor LT</b>
Graphics processor	RIVA TNT by nVidia	RIVA 128ZX by nVidia
RAMDAC pixel timing	250MHz	
On-board memory	8MB/16MB 1,6GB/s bandwidth	8MB 1,6GB/s bandwidth
BIOS	Flash-BIOS with VBE-3.0-Support	BIOS with VBE-3.0-Support
Bussystem	AGP, 2x (133MHz)	
VESA DDC	DDC1 and DDC2B	

## Address Assignment of the *ERAZOR II* and *VICTORY Erazor LT*

The *ELSA ERAZOR II and ELSA VICTORY Erazor LT* graphics board are fully IBM VGA compatible and occupies the same memory area and specific addresses in the I/O range. The memory range above 1 MB is automatically assigned through the PCI BIOS interface.



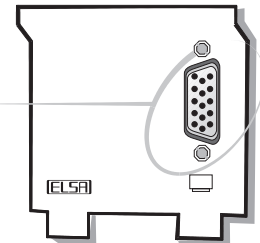
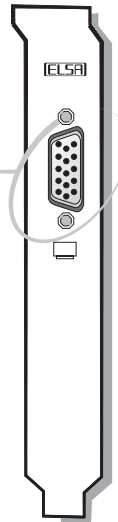
*If you come across any address conflicts, try to modify the I/O address of the expansion board causing the conflict. The addresses of the ELSA graphics boards cannot be changed! The ELSA ERAZOR II and ELSA VICTORY Erazor LT also requires an interrupt (IRQ) which is free. This may have to be reserved in the computer's BIOS. For help with this theme, refer to the manual for your mainboard.*

To ensure that your system functions properly, the addresses and ranges occupied by the ELSA graphics board must not be accessed simultaneously by other hardware components. The following addresses are assigned:

- **I/O addresses:**  
Standard VGA I/O (3B0-3DF)
- **Memory addresses:**  
Video RAM (A000-BFFF)  
Video BIOS-ROM (C000-C7FF)

## Ports on the Graphics Board

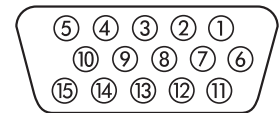
VGA D-shell socket  
Monitor connection socket  
(15-pin)



NLX version of the  
*VICTORY Erazor LT*

### The VGA D-Shell Socket

#### Pin Assignment



Connection	Signal	Connection	Signal
1	Red	9	+5 V
2	Green	10	Sync ground
3	Blue	11	Monitor ID2
4	Monitor ID0	12	Bidirectional data (SDA, DDC1/2B)
5	DDC ground	13	Horizontal synchronization
6	Red ground	14	Vertical synchronization
7	Green ground	15	Data timing (SCL, DDC2B)
8	Blue ground		

The *ELSA ERAZOR II* and *ELSA VICTORY Erazor LT* issue analog signals in accordance with the requirements of Guideline RS-170. The synchronization information is sent separately. If your monitor provides a switch for the input impedance, you should select '75 Ohms' (= '75  $\Omega$ ') for the R, G and B video inputs and '2 kOhm' (= '2 k $\Omega$ ') for the sync inputs. You should only try other switch settings at the sync inputs if your monitor expects sync levels other than those used by normal monitors and does not produce a stable display. The switches are labeled "Low" and "High" only on some monitors. You can then refer to your monitor manual to find out what input impedance level this refers to, or you can experiment to find a position in which a stable image appears in all graphics modes.

# Appendix

## Advice and Help



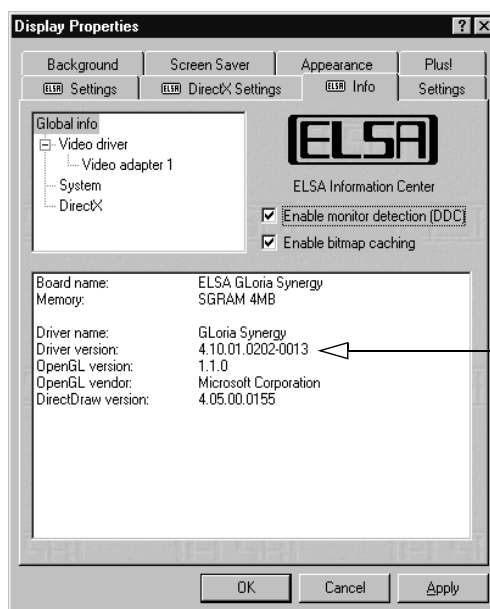
On the WINNERware CD you will find a list of the questions most frequently asked of the support hotline. In many cases you will quickly find a help for solving problems. The file can be read with the Acrobat Reader which is also included on the CD.

If you encounter any problems during the installation or operation of your ELSA product, please consult this manual first. On the ELSA CD or floppy disk you will find a file called README.TXT, containing late-breaking changes and additional information not available when this manual was printed.

If you have further questions, you can contact our Support team. Ensure that you can provide the following information.

- Exact model name of your ELSA device.
- Version of the used ELSA driver or file date and time of the driver file.
- Operating system, hardware environment and bus system.

You can call up information about your system via the ELSA Info program. Click on **Start ► Settings ► Display** to open the Display Properties window. Click on the **ELSA** Info tab for a display of various information about your system.



Especially important:  
The version number of your  
graphics board driver

- Name and version of the application program with the error.
- A detailed error description. To be certain, try to reproduce the error at least three times and exactly describe the steps you took to deliberately trigger the error.

## Who to Contact?

First you should contact the dealer where you bought your ELSA product. If there are still questions remaining, contact one of the following:

### ■ ELSA on the Internet

The ELSA Internet WWW site	www.elsa.com	
ELSA LocalWeb	+49-241-938800	
(ELSA's dial-up WWW site: no Internet provider required!)	ISDN	X75, V120, PPP
	Analog	V.90, V.34
	Protocol	PPP oder MLPPP
	User name	guest
	No password	

### ■ ELSA Support Faxline

By fax to the ELSA support faxline +49-241-606-6399

### ■ ELSA by Mail

Or write to ELSA

ELSA AG  
Computer Graphics Support  
Sonnenweg 11  
52070 Aachen  
Germany

### ■ ELSA Support Hotline

If very urgent, call the ELSA support hotline +49-241-606-6131

Mondays to Fridays from: 9.00 am until 5.00 pm (CET)

### ■ ELSA World Wide

You can contact the ELSA subsidiaries:

ELSA Inc.

2231 Calle De Luna  
Santa Clara  
California CA 95054  
USA

Phone: +1-408-919-9100  
+1-800-272-ELSA  
Fax: +1-408-919-9120

ELSA Asia Inc.

7F-11, No. 188, Sec. 5  
Nanking East Road  
Taipei 105  
Taiwan  
R.O.C.

Phone: +886-22-7685730  
Fax: +886-22-7660873

ELSA Japan Inc.

Mita Suzuki Building 3F  
5-20-14 Shiba, Minato-ku  
Tokyo 108-0014  
Japan

Phone: +81-3-5765-7391  
Fax: +81-3-5765-7235

## The ELSA LocalWeb

The ELSA LocalWeb provides direct access to ELSA's local Internet server, and contains the same information as the Internet web server [www.elsa.com](http://www.elsa.com). Here you will find information about all ELSA products, the latest drivers, software and documentation, and you have the opportunity to put questions to our sales and support departments via the ELSA news server. To access the ELSA LocalWeb, you need a dialer program (e.g. the Dial-up Network in Windows 95) and an Internet browser.

To make a connection, first start the dialer software. Where information for the DNS server is requested, enter the IP address as 172.22.1.2. The user name is guest; no password is necessary. With a successful connection active, the browser software can be started.

## Driver Updates

The latest versions of the ELSA drivers are always available for download from our Internet WWW site [www.elsa.com](http://www.elsa.com) or our LocalWeb and via direct FTP from [ftp.elsa.com](ftp://ftp.elsa.com). You will also find lots of information and answers to frequently asked questions (FAQs). You might also consider the newsgroups on our Webpages. Before you contact the ELSA Support team, please make sure that you are using the latest driver versions.

## Repair?

If you are not sure whether your ELSA expansion board is defective or if the problem is just a driver which is incorrectly installed, please call the ELSA support hotline before you send the board for repair. Should you need to send in the ELSA expansion board to be repaired, please use suitable packing material and the original box to prevent damage during transport. In addition, please include a copy of the original purchase receipt as well!

You can help reduce the repair time by including a detailed description of the fault with the device, which will help us track down the error source.

## DoC–Declaration of Conformity

ELSA AG VICTORY Erazor/LT-8 SD



Tested To Comply  
With FCC Standards

FOR HOME OR OFFICE USE

### Compliance Information Statement

(Declaration of Conformity Procedure)

Responsible Party: ELSA Inc.  
Address: 2231 Calle De Luna  
Santa Clara, CA 95054  
USA  
Phone: +1-408-919-9100  
Type of Equipment: Graphics Board  
Model Name: VICTORY Erazor/LT-8 SD

This device complies with Part 15 of the FCC rules.  
Operation is subject to the following two conditions:  
(1) this device may not cause harmful interference, and  
(2) this device must accept any interference received, including interference that may cause undesired operation.  
See user manual instructions if interference to radio reception is suspend.

On behalf of the manufacturer / importer  
this declaration is submitted by

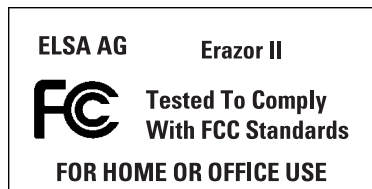
Aachen, July 31<sup>th</sup> 1998

A handwritten signature in black ink, appearing to read 'Peter Wieninger', written over a horizontal line.

Peter Wieninger  
VP Engineering  
ELSA AG, Germany







**Compliance Information Statement**  
(Declaration of Conformity Procedure)

Responsible Party: ELSA Inc.  
Address: 2231 Calle De Luna  
Santa Clara, CA 95054  
USA  
Phone: +1-408-919-9100  
Type of Equipment: Graphics Board  
Model Name: Erazor II

This device complies with Part 15 of the FCC rules.  
Operation is subject to the following two conditions:  
(1) this device may not cause harmful interference, and  
(2) this device must accept any interference received, including interference that  
may cause undesired operation.  
See user manual instructions if interference to radio reception is suspected.

On behalf of the manufacturer / importer  
this declaration is submitted by

Aachen, August 12<sup>th</sup> 1998

Peter Wieninger  
VP Engineering  
ELSA AG, Germany

# Warranty Conditions

The ELSA AG warranty is given to purchasers of ELSA products in addition to the warranty conditions provided by law and in accordance with the following conditions:

## 1 Warranty Coverage

- a) The warranty covers the equipment delivered and all its parts. Parts will, at our sole discretion, be replaced or repaired free of charge if, despite proven proper handling and adherence to the operating instructions, these parts became defective due to fabrication and/or material defects. Also we reserve the right to replace the defective product by a successor product or repay the original purchase price to the buyer in exchange to the defective product. Operating manuals and possibly supplied software are excluded from the warranty.
- b) Material and service charges shall be covered by us, but not shipping and handling costs involved in transport from the buyer to the service station and/or to us.
- c) Replaced parts become property of ELSA.
- d) ELSA are authorized to carry out technical changes (e.g. firmware updates) beyond repair and replacement of defective parts in order to bring the equipment up to the current technical state. This does not result in any additional charge for the customer. A legal claim to this service does not exist.

## 2 Warranty Period

The warranty period for ELSA products is six years. Excepted from this warranty period are ELSA color monitors and ELSA videoconferencing systems with a warranty period of 36 months. This period begins at the day of delivery from the ELSA dealer. Warranty services do not result in an extension of the warranty period nor do they initiate a new warranty period. The warranty period for installed replacement parts ends with the warranty period of the device as a whole.

## 3 Warranty Procedure

- a) If defects appear during the warranty period, the warranty claims must be made immediately, at the latest within a period of 7 days.
- b) In the case of any externally visible damage arising from transport (e.g. damage to the housing), the transport company representative and ELSA should be informed immediately. On discovery of damage which is not externally visible, the transport company and ELSA are to be immediately informed in writing, at the latest within 7 days of delivery.
- c) Transport to and from the location where the warranty claim is accepted and/or the repaired device is exchanged, is at the purchaser's own risk and cost.
- d) Warranty claims are only valid if the original purchase receipt is returned with the device.

## 4 Suspension of the Warranty

All warranty claims will be deemed invalid

- a) if the device is damaged or destroyed as a result of acts of nature or by environmental influences (moisture, electric shock, dust, etc.),
- b) if the device was stored or operated under conditions not in compliance with the technical specifications,

- c) if the damage occurred due to incorrect handling, especially to non-observance of the system description and the operating instructions,
- d) if the device was opened, repaired or modified by persons not authorized by ELSA,
- e) if the device shows any kind of mechanical damage,
- f) if in the case of an ELSA Monitor, damage to the cathode ray tube (CRT) has been caused especially by mechanical load (e.g. from shock to the pitch mask assembly or damage to the glass tube), by strong magnetic fields near the CRT (colored dots on the screen), or through the permanent display of an unchanging image (phosphor burnt),
- g) if, and in as far as, the luminance of the TFT panel backlighting gradually decreases with time, or
- h) if the warranty claim has not been reported in accordance with 3a) or 3b).

## **5 Operating Mistakes**

If it becomes apparent that the reported malfunction of the device has been caused by unsuitable software, hardware, installation or operation, ELSA reserves the right to charge the purchaser for the resulting testing costs.

## **6 Additional Regulations**

- a) The above conditions define the complete scope of ELSA's legal liability.
- b) The warranty gives no entitlement to additional claims, such as any refund in full or in part. Compensation claims, regardless of the legal basis, are excluded. This does not apply if e.g. injury to persons or damage to private property are specifically covered by the product liability law, or in cases of intentional act or culpable negligence.
- c) Claims for compensation of lost profits, indirect or consequential detriments, are excluded.
- d) ELSA is not liable for lost data or retrieval of lost data in cases of slight and ordinary negligence.
- e) In the case that the intentional or culpable negligence of ELSA employees has caused a loss of data, ELSA will be liable for those costs typical to the recovery of data where periodic security data backups have been made.
- f) The warranty is valid only for the first purchaser and is not transferable.
- g) The court of jurisdiction is located in Aachen, Germany in the case that the purchaser is a merchant. If the purchaser does not have a court of jurisdiction in the Federal Republic of Germany or if he moves his domicile out of Germany after conclusion of the contract, ELSA's court of jurisdiction applies. This is also applicable if the purchaser's domicile is not known at the time of institution of proceedings.
- h) The law of the Federal Republic of Germany is applicable. The UN commercial law does not apply to dealings between ELSA and the purchaser.



# Glossary

- **3D** – Three-dimensional
- **3D clipping** – Process in geometric transformation in which invisible surfaces or parts of a 3D object are removed.
- **3D pipeline** – Sum of all steps required for the representation of virtual 3D scene on the monitor. These include →tessellation, →geometrical transformation and →rendering.
- **AGP** – stands for Accelerated Graphics Port and is a further development by INTEL based on the PCI bus. The AGP bus provides a greater bandwidth for data transmission and communicates directly with main memory. The bus is primarily intended for 3D graphics boards.
- **Aliasing** – the familiar "staircase effect". Jagged transitions are often formed between adjacent pixels in the representation of diagonals or curves. These "jaggies" can be smoothed out by anti-aliasing.
- **Alpha blending** – Additional information for each pixel for creating transparent materials.
- **Back buffer** – is the name for the image region built up in the background in the frame buffer during →double buffering.
- **Back face culling** – Method used to calculate the hidden faces of a 3D object.
- **BIOS** – Abbreviation of Basic Input/Output System. A program code in the read-only memory (ROM) of a computer which performs the self-test and several other functions during system startup.
- **Bump mapping** – Process by which textures are assigned depth information which allows the display of relief or raised structures.
- **Bus system** – A system of parallel data lines for the transfer of information between individual system components, especially to expansion boards (e.g. PCI bus).
- **Clipping** – parts of polygons invisible to the representation are determined in clipping. These parts are then not displayed.
- **D/A converter** – Digital/Analog converter: A signal converter which converts a digital input signal to an analog output signal.
- **DDC** – stands for Display Data Channel. A special data channel through which a DDC-capable monitor can send its technical data to the graphics board.
- **Depth Complexity** – refers to the number of objects that are in front of each other within a scene. For example, a wall behind a group of people, with yet another person in front of them, results in a depth complexity of 3. This is a typical value for 3D environments.
- **DirectColor** – Generic term for TrueColor, RealColor and HighColor. The value that is stored in the video RAM is not translated but transferred directly to the D/A converter. This means that the full color information must be saved for each pixel.
- **Double buffering** – means that there are two display buffers. This means that the next image can be drawn in the page of the display buffer, which is initially invisible. This image will be displayed once it is ready and the next image will be prepared in the other page of the buffer. Animations and games can be made to look more realistic with this technique than with simple single buffer.

- **DPMS** – Abbreviation of VESA Display Power Management Signaling. This standard allows an energy-saving operation of monitors in several steps. The graphics boards described in this manual support VESA DPMS.
- **DRAM** – Abbreviation of Dynamic Random Access Memory. Volatile memory for read and write operations.
- **EDO-RAM** – Abbreviation for Extended Data Output Random Access Memory (Hyper Page Mode). EDO-RAM is very common on graphics boards, as the most recently used data persist in memory. A number of read accesses to similar data occur during the generation of an image, so that use of EDO-RAM gives a significant speed advantage.
- **FCC** – FCC compliance means that a device has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules, designed to provide reasonable protection against harmful interference in a residential installation.
- **FIFO method** – (first in, first out) a system used in batch processing and queues in which the first signal to arrive is processed first.
- **Fill Rate** – Is the rate at which pixels are drawn into the screen memory, and expresses the overall performance of the processor. Current values are around 50-70 Mpixels/s. With increasing demands of resolution, →depth complexity and fps, the fill rates will have to increase dramatically.
- **Fixed-frequency monitor** – A monitor that can only be operated at a specific resolution and refresh rate.
- **Flat shading** – →'Shading'.
- **Flipping** – The image generated in the →back buffer is displayed.
- **Fps** – Or frame rate, refers to how many times per second the scene is updated by the rendering engine. Frame rates beyond 30 fps achieve smoother, more realistic animation.
- **Frame buffer** – Part of the graphics memory in which the image next to be displayed on the screen is generated. In addition, transparency effects are calculated in the frame buffer.
- **Front buffer** – is the name for the visible image page in →double buffering.
- **Geometrical transformation** – The position of the object in space is determined from the observer's point of view.
- **Gouraud shading** – →'Shading'.
- **Graphics accelerator** – refers to a graphics accelerator board, i.e a board particularly suited for graphics intensive user environments.
- **HighColor** – designates a 15-bpp or 16-bpp (bits per pixel) graphics mode, i.e. 32,768 or 65,536 colors.
- **Horizontal frequency** – The horizontal frequency (scan frequency) of a monitor in kHz. This value must be set in accordance with the operating limits of the monitor, otherwise the monitor might be damaged in extreme cases.
- **Horizontal scan frequency** – The horizontal scan frequency of a monitor in kHz. This value must be set in accordance with the operating limits of the monitor, otherwise the monitor might be damaged in extreme cases.
- **Interpolation** – A video image must be stretched or shrunk in order to fit into the display window. If pixels are simply multiplied (for example, a block of four equally colored pixels represents the original pixel), aliasing effects ("blocks" and "stairs") will occur. This can be avoided by interpolation procedures (using

average colors for inserted pixels). Horizontal interpolation is relatively easy to perform, since the pixels are drawn to the screen in lines. Vertical interpolation is more difficult and requires a complete pixel line to be buffered.

- **MIP mapping** – In MIP mapping a number of textures are assigned to an object depending on distance. The representation of the object becomes more detailed as the observer approaches the object.
- **Multifrequency/Multisync monitor** – A monitor that can be operated at various horizontal scan frequencies, or that automatically adapts itself to different video signals (resolutions).
- **OpenGL** – 3D software interface (3D API). E.g. implemented in Windows NT and available for Windows 95. Based on Iris GL from Silicon Graphics and licensed from Microsoft.
- **Page Flipping** – The image generated in the →back buffer is displayed
- **PCI bus** – Abbreviation of Peripheral Component Interconnect Bus. An advanced bus system, i.e. a system of parallel data lines to transfer information between individual system components, especially to expansion boards.
- **Phong shading** – → 'Shading'.
- **Pixel** – Picture element. Dot in the image.
- **Pixel frequency** – Pixel clock frequency (number of pixels drawn per second in MHz).
- **Primitive** – Simple, polygonal geometrical object, such as a triangle. 3D landscapes are generally broken down into triangles.
- **RAM** – Abbreviation of Random Access Memory. Chip memory of a computer or expansion board that can be read from and written to (unlike ROM = Read Only Memory).
- **RAMDAC** – The RAMDAC converts the digital signals to analog signals on a graphics board. VGA monitors are only capable of processing analog signals.
- **RealColor** – RealColor normally designates a 15-bpp or 16-bpp (bits per pixel) graphics mode, i.e. 32,768 or 65,536 colors).
- **Refresh rate** – or image refresh frequency (in Hz) indicates how many times per second an image on the monitor is refreshed.
- **Rendering** – Process for calculating the representation of a 3D scene, in which the position and color of each point in space is determined. The depth information is held in the →Z buffer, the color and size information is held in the →frame buffer.
- **Resolution** – The number of pixels in horizontal and vertical direction on the screen, for example 640 horizontal by 480 vertical pixels (640 x 480).
- **RGB** – Color information is saved in the Red/Green/Blue color format.
- **ROM** – Abbreviation of Read Only Memory. Semiconductor memory that can only be read and not written to.
- **Shading** – Shading or rendering is a way to define the colors on curved surfaces in order to give an object a natural appearance. To achieve this, the surfaces are subdivided into many small triangles. The three most important 3D shading methods differ in the algorithm used to apply colors to these triangles:  
Flat shading: the triangles are uniformly colored.  
Gouraud shading: The color shades on a triangle are calculated by interpolating the vertex colors, resulting in a smooth appearance of the surface.  
Phong shading: the color shades on a triangle

are calculated by interpolating the normal vector.

- **Single buffer** – By contrast with double buffering, where the image buffer is duplicated, the single buffering mode is not able to access the next image, which has already been calculated. This means that animations will run jerkily.
- **Tearing** – A distinction is made in double buffering between the front buffer and the back buffer. The image change between the front buffer and the back buffer is synchronized in tearing.
- **Tessellation** – The objects for 3D calculations are divided up into polygons (triangles) in tessellation. The vertices, color and, if required, transparency values, are determined for the triangles.
- **Textures** – Wrapping a bitmap around an object, including perspective correction, for example wallpaper on a wall or a wood texture on furniture. Even a video can be used as a texture map.
- **TrueColor** – Graphics mode with 16.7 million colors (24 or 32 bits per pixel). In this mode, the color information saved in the display memory is not translated by a look-up table, but passed directly to the D/A converter. This means that the full color information must be saved for each pixel.
- **VESA** – Abbreviation of Video Electronics Standards Association. A consortium for the standardization of computer graphics.
- **VRAM** – Abbreviation for video RAM. Memory chip for fast graphics boards.
- **Z buffer** – 3D depth information (position in the third dimension) for each pixel.



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