ELSA GLoria™ DCC

ELSA is DIN EN ISO 9001 certified. The accredited TÜV CERT certification authority has confirmed ELSA conformity to the worldwide ISO 9001 standard in certificate number 09 100 5069, issued on June 15, 1998.

You can find all declarations and approvals for the products, as long as they were available at the time of publication, in the appendix of this documentation or on the ELSA website at www.elsa.com.

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Preface

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Thank you for placing your trust in this ELSA product

With the *ELSA GLoria DCC* you have selected a graphics board which was designed as a product for visualisation and animation. The graphics processor on the board ensures high-speed generation of on-screen graphics making this board ideal for Digital Content Creation (DCC) applications. ELSA products are subject to the highest standards in production and quality control, which are the foundations of consistantly high product quality.

About this manual

This manual provides all the information you will need to get the best out of your ELSA graphics board. For instance, which resolution is best for which monitor? The accompanying ELSA utility programs are described.

Changes to this manual

ELSA products are subject to continual development. It is therefore possible that the information printed in this manual is not current in all respects. Curent information about updates can always be found in the README files on the ELSA CD.

If you have further questions or need additional help, you can rely on our online services which are available to ELSA customers.

Before you read on...

The installation of the ELSA GLoria DCC hardware and drivers is described in full in the installation guide which accompanies this manual. You should refer to that document before attempting to install your board.

Contents

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1 Introduction

Extremely fast, reliable and optimised for 3D Studio MAX from Discreet—with these properties the *ELSA GLoria DCC* is the ideal tool for the professional use of the world's most popular software for digital content creation.

1.1 Highlights of the *ELSA GLoria DCC*

- ELSA workstation performance for 3D Studio MAX 4
- NVIDIA Quadro DCC processor
- Over 3.2 billion texture mapping pixels per second
- Memory bandwidth 7.3 GB per second
- 350 MHz RAMDAC
- 64 MB ultra-fast DDR SDRAM (unified memory)
- Analog or digital monitor connection
- TV-out connection
- Application drivers for 3D Studio MAX
- Support via Internet and hotline
- Six-year warranty

1.2 What's in the box?

You will need to check that the box contains all of the following:

- Graphics board
- Installation Guide
- Manual on CD
- CD-ROM with installation and driver software and utilities
- TV-out adaptor cable

If any part is missing please contact your dealer. ELSA reserves the right to vary the products supplied without prior notice. The current scope of delivery is described on our web site.

1.3 What hardware do I need?

- **Computer:** A PC, preferably with a Pentium III or Pentium 4 or AMD Athlon or Thunderbird and a minimum of 128 MB RAM is required.

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- **Monitor:** The *ELSA GLoria DCC* works with a standard IBM VGA compatible analog monitor with a horizontal scan frequency of at least 31.5 kHz or with a digital (DVI-D or DVI-I) monitor.

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2 After installing the drivers

In this chapter you will find descriptions of:

- where you can find the software for operating the *ELSA GLoria DCC*
- the performance characteristics of your graphics board,
- the most effective tuning for the combination of monitor and ELSA graphics board.

2.1 Software installation from the CD

The ELSA GLoria DCC is supplied with software on a CD-ROM. You will find all the utilities described in this manual on the ELSA GLoria DCC CD—unless they are a component of the operating system.

Once you have successfully completed the steps described in the Installation Guide, your ELSA driver is integrated into your computer system with installed drivers. If the autostart function for your CD-ROM drive under Windows has been switched off, the setup program on the *ELSA GLoria DCC* CD will not start automatically. It can be found and started manually from the root directory of the CD and is called Autorun.EXE.

The greater part of the installation is automated; ELSA setup detects the installed operating system and ELSA graphics board(s).

2.2 The right settings

After installing the drivers the display is set to the lowest values, namely 640 x 480 resolution with 256 colors and 60 Hz refresh rate. Your first task is to increase all these values to a more comfortable level, especially the refresh rate, which is best set to at least 75 Hz to avoid flickering.

Our tip is: Invest a little time at this stage and you won't regret it. Take the time to optimally tune your combination of monitor and graphics board. Your eyes will thank you for it, and you are guaranteed to have more fun in front of your screen.

To set up your system properly, the following questions should be answered:

- What is the maximum resolution I can set on my system?
- Which color depth do I want to use?
- How high should the refresh rate be set?

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2.2.1 What are your options?

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

ELSA GLoria DCC	Output		Resolutions with Z buffering/ double buffering	
Pixel	VGA (Hz)	DVI (Hz)	HighColor (16 bit)	TrueColor (32 bit)
2048 x 1536	85	–	■	■
1920 x 1440	97	–	■	■
1920 x 1200	113	–	■	■
1920 x 1080	125	–	■	■
1600 x 1200	135	–	■	■
1600 x 1024	162	–	■	■
1280 x 1024	198	75/60	■	■
1280 x 960	200	75/60	■	■
1152 x 864	200	75/60	■	■
1024 x 768	200	75/60	■	■
800 x 600	200	75/60	■	■
640 x 480	200	75/60	■	■

HighColor = 65,536 colors, TrueColor = 16.7 million colors

2.2.2 What is best for what situation?

There are some basic ground rules for you to follow when setting up your graphics system. On the one hand, there are the ergonomic guidelines, although nowadays these are met by most systems, and on the other hand there are limitations inherent to your system, e.g. your monitor. The question of whether your applications need to run using large color depths—perhaps even TrueColor—is also important. This is an important condition for DCC workstations.

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"More pixels, more fun"

This is an opinion which is widespread, but which is not entirely true under all circumstances. The general rule is that a refresh rate of 85Hz meets the minimum ergonomic requirements. The resolution to be selected also depends on the capabilities of your monitor. The table below is a guide to the resolutions you might select:

Monitor size	Typical image size	Minimum resolution	Maximum resolution	Ergonomic resolution
17"	15,5"–16,0"	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"	19,0"–20,0"	1024 x 768	1600 x 1200	1280 x 1024
24"	21,0"–22,0"	1600 x 1000	1920 x 1200	1600 x 1000

2.3 Changing the resolution

2.3.1 Windows 2000

The settings for the graphics driver are included in the Control Panel under Windows 2000.

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.

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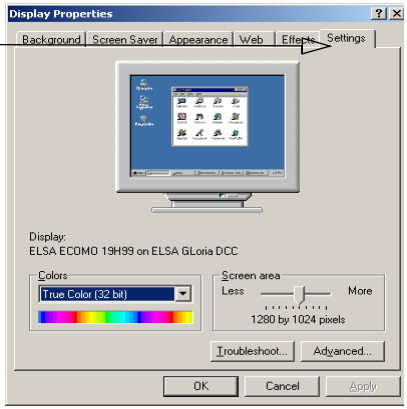
The 'Settings' tab has all the options for setting up the graphics board for your monitor.



① Click on the 'Settings' tab.

② Click **Advanced...** in the 'Settings' dialog.

③ Select the 'Adapter' tab in the dialog that opens.

④ A button labeled **List all Modes...** is located in the lower part of the window. Click it to view a list of all configurable combinations of resolution, color depth and refresh rate. The values in the list depend on the capabilities of the monitor and graphics board. Select the desired combination and confirm by pressing **OK**.

⑤ When finished, click **Apply...** to check the new settings. You are then given the option of selecting or canceling the chosen settings. If you are satisfied with the new combination, confirm your selection by pressing **OK**.

You will find further information on how to customize your graphics settings under Windows 2000 in your system manual.

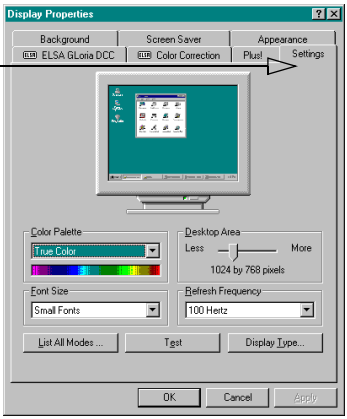
2.3.2 Windows NT 4.0

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.

The 'Settings' tab has all the options for setting up the graphics board for your monitor.



You can select the possible settings for 'Color Palette', 'Font Size', 'Desktop area' and 'Refresh 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.

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3 Useful stuff and more

In addition to the ELSA drivers, the *ELSA GLoria DCC* CD also contains additional programs and utilities for use with the *ELSA GLoria DCC*, a selection of which we will introduce here. Information about other programs can be taken from the README files on the CD.

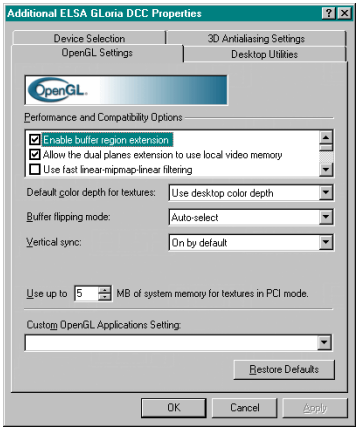
3.1 OpenGL API application settings in Windows NT

The OpenGL API application settings are automatically installed when you install the ELSA driver. To access these settings, press the right mouse button on the desktop and click on 'Properties'. The 'Display Properties' window appears, select the 'GLoria DCC' tab and click on 'Additional Properties' near the bottom of the window.

A further 'Additional ELSA GLoria DCC Properties' window appears, select the 'Custom OpenGL Applications Setting' drop-down list near the bottom of the window to optimize the OpenGL API for any of the programs listed, or alternatively select the parameters you desire. Utilize the context sensitive help for an explanation of the various settings.

Please note that you must not have the program running that you want to optimize (e.g. 3D Studio MAX) when choosing the application settings.

In the 'Custom OpenGL Applications Setting' drop-down list you can determine the desired 3D parameters for each application.
A list containing the most common applications allows you to quickly set the optimum configuration. Please note that the optimized settings are 'silent'. That means that the OpenGL API is optimized although you see no changes to the performance and compatability options in the 'OpenGL Settings' tab.



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Press F1 or click on the Help button to call up the online help. The online help has more detailed information on the application settings.

3.2 OpenGL API application settings in Windows 2000

Similar to Windows NT 4.0, the OpenGL API application settings are automatically installed when you install the ELSA driver. To access these settings, press the right mouse button on the desktop and click on 'Properties'. The 'Display Properties' window appears, select the 'Settings' tab and click on 'Advanced' near the bottom of the window.

A further window appears, select the 'GLoria DCC' tab, then 'Additional Properties' near the bottom of the window. Select the 'OpenGL Settings' tab near the bottom of the window to optimize the OpenGL API for any of the programs listed, or alternatively select the parameters you desire. Utilize the context sensitive help for an explanation of the various settings.

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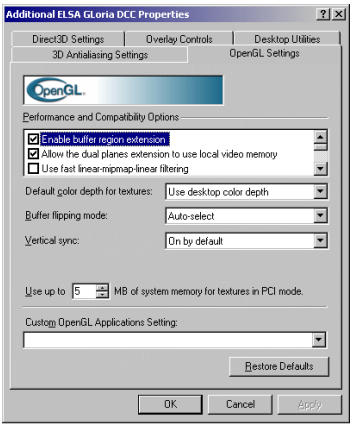

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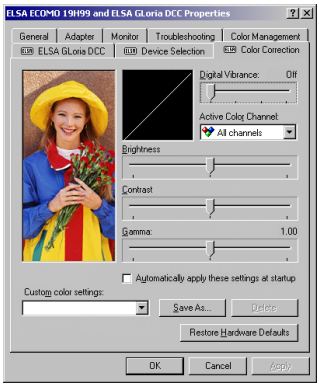
3.3 Color Correction



The 'Color Correction' application permits the optimal adjustment of the color and brightness of your monitor.

The midrange tones of photographs or game scenes often appear too dark due to technically inevitable non-linearities in the brightness of CRT screens, or as a result of a variety of image compression algorithms. Attempts to compensate these errors using the brightness and contrast controls generally available on monitors usually results in an overall worsening of the display quality. Generally the brighter parts of the image will be washed out, or the image as a whole will appear too hard.

Color correction affects the processing of image information on the graphics board (i.e. before the signal reaches the monitor), thus permitting a targeted adjustment of the midrange brightness. As a result, you can then take advantage of the full contrast and brightness ranges of your monitor.

3.4 Tools for 3D Studio MAX/VIZ

You can achieve significantly improved working speeds and ergonomics with the drivers and extensions for 3D Studio MAX.

3.4.1 ELSA MAXtreme

ELSA offers a special driver for 3D Studio MAX and VIZ. The optimization of the ELSA driver lets you reach higher display speeds and thus is indispensable for the *ELSA GLoria DCC*.

3D Studio MAX and VIZ are powerful applications for modeling, rendering, visualizing and animating 3D objects. The software package includes two standard graphics drivers to be used alternatively with differing performance characteristics—a HEIDI driver (software Z buffer/SZB), and an OpenGL API driver (for hardware acceleration).

ELSA is the only manufacturer of graphics boards to have developed an optimized solution to increase user productivity and fully exploit existing performance reserves: ELSA MAXtreme is a special driver for 3D Studio MAX/VIZ

which makes the most of the special features of the *ELSA GLoria* and *ELSA Synergy* graphics boards. It offers many improvements over standard drivers and thus considerable increases in performance and productivity when used with these applications.

Features and benefits

By developing a driver tailored to 3D Studio MAX and 3D Studio VIZ, ELSA's software developers have laid the foundation for further optimization and new functions which will be available only in *ELSA GLoria* and *ELSA Synergy* graphics accelerators in the future.

By using ELSA MAXtreme, many effects which would otherwise not be visible until the final video-rendering stage can be displayed during the creative phase in "working view". These include:

a) Transparency: Normally, transparent objects are displayed in 3D Studio MAX/VIZ by stippled "clouds" of varying densities ("stippled" or "screen door" process). This shows, to an extent, whether an object is transparent or not and how translucent it is. Even so, the visual impression it gives is not one of a transparent object. ELSA MAXtreme allows you to select:

① Whether transparent objects are at all displayed in a transparent way (non-transparent display of transparent objects is, of course, particularly fast);

② Whether to use the standard method described above;

③ Whether transparent objects are actually displayed as transparent, i.e. by blending the transparent object's color with the color of the objects located behind them.

A further improvement is spatial sorting of transparent objects before they are displayed ('sorted blending') which gives a perfect impression of transparency even where there are any number of transparent objects in the scene.

b) Fog: Normally, no fogging is displayed in 'Working View' mode. However, ELSA MAXtreme also supports 3D Studio's standard fogging. This means that at an early stage one gets a realistic impression of a fogged scene. Animated too, of course.

Installation

① Ensure that 3D Studio MAX/VIZ has not been started.

② Insert the *ELSA GLoria DCC* CD into the CD-ROM drive and start the **Setup.EXE** program from the directory '<your CD drive, normally D>:\Apps\MAXtreme'.

The program guides you through each step of the installation. Read the instructions carefully, and answer and confirm each of the questions.

Further information on this special driver can be found in the README.TXT file in the directory on the ELSA GLoria DCC CD.

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4 TV-out interface

This chapter describes the possibilities available with the TV-out adapter.

4.1 One interface—many possibilities

The TV-out interface enables a whole new range of uses for the *ELSA GLoria DCC*. Here are some tips and ideas to get you started:

- With your television, you can
  - finally experience the real action of the games. A sound card will make your game playing a multimedia pleasure.
  - enjoy the DVD films in full view.
- A professional projector with video input
  - brings your games and DVD films to the screen. You will really have a movie theater in your living room!
  - displays your presentations in large format for a large group of interested viewers.
- With your video recorder, you can
  - record games sequences as video. Your heroic campaign against the Orcs can be preserved for posterity on video tape. Or incorporate some digital specials into your tape of your family.

4.1.1 From the VGA signal to the TV signal

Unlike a computer monitor, a television set is not able to process the VGA signals from a graphics board. This is obvious if the 15-pin monitor output on the back of the graphics board is compared with a TV antenna cable. The signals travel in fundamentally different ways. The TV-out interface of the *ELSA GLoria DCC* is thus equipped with its own "interpreter", a chip which converts VGA signals for the television. This TV signal is of course also recognized by other devices—such as a projector with TV signal input or a video recorder.

4.1.2 What kind of device can be attached?

You can connect any standard TV or video device to the TV-out interface for the *ELSA GLoria DCC*. The TV output works in accordance with the S-video standard. Modern devices with an S-video interface (compatible to Hi-8 sig-

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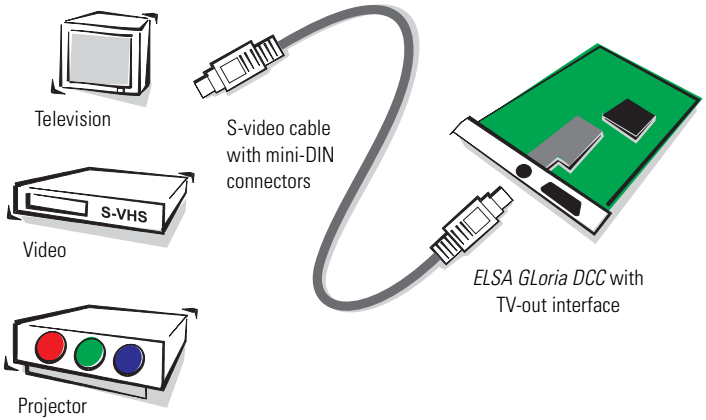
nal) can therefore be connected to the TV-out interface. Older devices often have only a composite input (also referred to as an FBAS input). An adapter cable is included so that you can also connect these devices to the TV-out interface.

The best choice for devices that have both an S-video and a composite input is the modern S-video connection. This will give you a better display quality.

The TV-out interface can generate signals conforming to the PAL and NTSC standards. Refer to the operating instructions for your television or video device to find out what signal standards it supports.

4.1.3 Direct connection of S-video devices

Devices with S-video input can be connected directly to the TV output. Use an S-video cable with two mini-DIN connectors. These cables can be obtained form any dealer.



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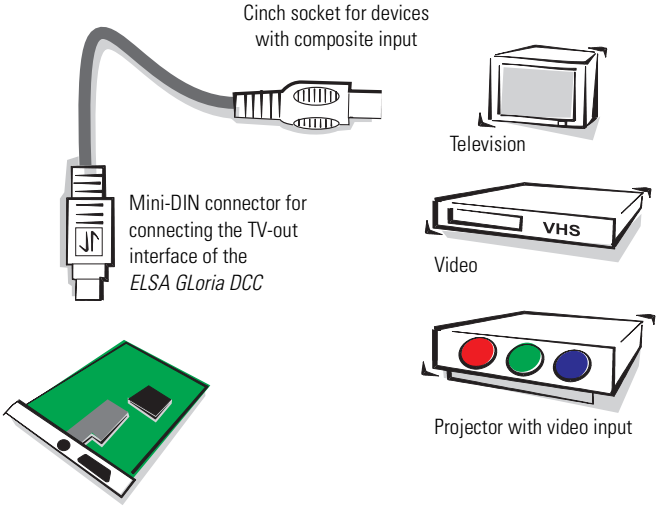
4.1.4 Connecting TV devices with the adapter cable

To connect TV devices with composite or FBAS input use the adapter cable included with your *ELSA GLoria DCC*.



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5 Graphics know-how

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

5.1 3D graphics representation

Today it is considered a basic requirement 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.

5.1.1 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). The basic geometric primitive is the triangle. The corner points of the object's triangles are described using coordinate points (x, y and z), where the 'z' value represents the depth information. Depending on the display representation, these points are assigned additional data regarding material, texture, special effects and much more. As a result, an enormous amount of data is sent into the pipeline.

RenderingRasterization

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

- **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 faceted representation, which requires only short computation times.
- 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.

- **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. Information concerning the transparency of the texture is carried in the alpha channel. 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.

  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.

- **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. The front buffer is the memory area

where the image that appears on the monitor is located. This prevents the process of image drawing being visible. The duplicate storage method is also known as double buffering.

Buffer swapping: Display on the monitor

Two possibilities exist for transferring a completed image from the back to the front buffer, and thus to the display. The obvious method is to copy the contents to the front buffer one byte at a time, a process known as "blitting". Page flipping is significantly faster: in this case the content of the buffer is not rewritten—the addresses of the front and back buffers are simply exchanged. As a result, only tiny data volumes are transferred.

The buffer swapping will only ever be performed 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). This is a very important value especially for 3D applications. A cinema film runs at 24 fps.

5.2 3D interfaces

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

In simple terms: They make developers' work easier. 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.

5.2.1 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 API. ELSA graphics boards support these commonly

found 3D interfaces. The functional differences between the interfaces are slight. Your *ELSA GLoria DCC* supports the following APIs.

5.2.2 DirectX

Microsoft DirectX is a suite of multimedia APIs that are built into Microsoft Windows operating systems. DirectX provides a standard development platform for PCs by enabling software developers to access specialized hardware features without having to write hardware-specific code.

DirectX offers a single set of APIs (application programming interfaces) that provides improved access to the advanced features of high-performance hardware such as 3-D graphics acceleration chips and sound cards. These APIs control the "low-level functions", including 2-D graphics acceleration; support for input devices such as joysticks, keyboards, and mice; and control of sound mixing and sound output. Low-level functions are supported by the components that make up DirectX: Microsoft DirectDraw, Microsoft Direct3D, Microsoft DirectInput, Microsoft DirectSound, Microsoft DirectPlay, DirectShow, and Microsoft DirectMusic.

DirectX provides a "hardware abstraction layer" (HAL), which uses software drivers to communicate between game software and computer hardware. As a result, developers can use DirectX to write a single version of their product without worrying about the wide range of hardware devices and configurations in existence.

DirectX also provides developers with tools that help you get the best possible performance from the machine you're using. It automatically determines the hardware capabilities of your computer and then sets the application's parameters to match. With DirectX, you can even run multimedia applications that require support for features your system doesn't have by simulating certain hardware devices through a "hardware emulation layer" (HEL), which provides software-based drivers that act like hardware.

DirectX 8.0

The most recent version of DirectX offers updated graphics, faster frame rates, and support for multiplayer games. It also offers better audio when running and displaying programs rich in multimedia elements such as full-color graphics, video, 3-D animation, and surround sound.

For further information see http://www.microsoft.com/directx/

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5.2.3 The OpenGL API

Since the OpenGL API was introduced in 1992, it has grown into the industry's leading cross-platform 2D and 3D graphics API and its presence continues to grow every day.

The OpenGL API 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. The OpenGL API 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 the OpenGL API provide software developers access to these graphics capabilities:

For further information see the Internet site www.sgi.com/software/opengl.

5.2.4 Color palettes, TrueColor and gray scales

Common graphics modes are listed in the following table. Not all graphics modes are available on the ELSA boards:

Graphics mode	bpp	bpg	Colors (from palette)	Max. gray levels
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	16	5+6+5	65,536	32
TrueColor	24	8+8+8	16.7 million	256
	32	8+8+8	16.7 million	256

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

5.2.5 VGA

In VGA graphics boards, 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.

5.2.6 DirectColor

The situation is different in the case of DirectColor (TrueColor 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 TrueColor and HighColor can be confused, as they are not always used unambiguously.

HighColor

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

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).

5.2.7 VESA DDC (Display Data Channel)

The Display Data Channel provides a serial data channel between the monitor and the graphics board, as long as both support DDC and the monitor cable includes the additional DDC wire. An extended monitor cable is used. This feature allows the monitor data to be sent automatically to the graphics board (e.g. name, type, max. horizontal frequency, timing definitions etc.) or even for the graphics board to send instructions to the monitor.

There are various standards; DDC2B and DDC2AB.

5.2.8 DDC2B

A bi-directional data channel based on the I^2C access-bus protocol is used for the communication between monitor and 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 (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).

5.2.9 DDC2AB

With DDC2AB additional to DDC2B, the computer can send commands for controlling the monitor, e.g. for adjusting the screen position or the brightness (similar to ACCESS bus). Modern monitors and graphics boards no longer use this standard.

The pin assignment of the VGA D-shell socket can be found in the chapter 'Technical data'.

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6 Technical data

Those with a technical interest will find more detailed information regarding the *ELSA GLoria DCC* in this chapter. All interfaces and their assignments are described in detail.

6.1 Characteristics of the graphics board

	ELSA GLoria DCC
Graphics processor	Quadro DCC by NVIDIA
RAMDAC pixel clock	350 MHz
On-board memory	64 MB DDR SDRAM
BIOS	64kB Flash BIOS with VBE 3.0 support
Bus system	AGP, 1x/2x/4x (AGP 4x is only supported by certain mainboard types such as Intel 820, Intel 840 and Intel 850)
VESA DDC	DDC2B

6.2 ELSA graphics board addresses

The ELSA graphics boards are 100% IBM VGA compatible and occupy 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 graphics board 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 (A0000-BFFFF)

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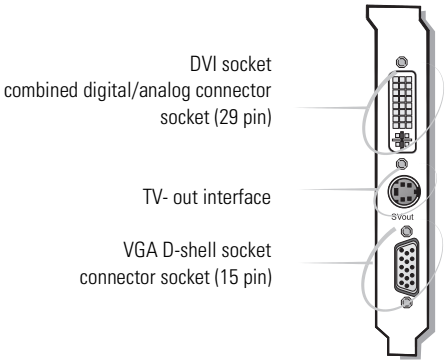
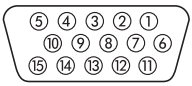
Video BIOS-ROM (C0000-C7FFF)

6.3 Ports on the graphics board



6.3.1 The VGA D-shell socket



Pin assignments

Pin	Signal	Pin	Signal
1	red	9	+5V
2	green	10	sync ground
3	blue	11	not assigned
4	not assigned	12	bidirectional data (SDA, DDC2)
5	ground	13	horizontal synchronization
6	red ground	14	vertical synchronization
7	green ground	15	data clock (SCL, DDC2)
8	blue ground		

The *ELSA GLoria DCC* issues analog signals in accordance with the requirements of directive RS-170. The synchronization information is sent sepa-

rately. If your monitor supports the switching of input impedance, the '75 Ohm' setting (= '75Ω') should be chosen for the R, G and B video inputs and the '2 kOhm' setting (= '2kΩ') should be set for the sync inputs. You should not try other switch settings at the sync inputs unless your monitor expects a sync level that differs from that of most common monitors and does not produce a stabile image. In some cases, the switch settings are labeled only with 'Low' and 'High'. If this is the case, either you can look up the Ohm values for the switch settings in the user manual provided with your monitor or you can try both settings to see which one produces a stabile image in all of the graphic display modes you require.

6.3.2 The TV out interface

Pin assignments

Pin	Signal	Pin	Signal
1	GND, mass (Y)	3	GND, mass (C)
2	Y, intensity (luminance)	4	C, color (chrominance)

6.3.3 The DVI interface

The combined Digital Visual Interface (DVI) provides a high-speed digital connection for digital monitors and also supports the connection of analog monitors. DVI enbles hot plug&play and is also display-technology independent. Combined DVI enables:

- Loss-free digital transfer from PC to monitor;
- Digital and analog support in a single connector;
- Plug&play using hot plug detection, EDID and DDC2B.

The combined connector includes 29 signal contacts, divided into a digital section consisting of three rows of eight contacts and an analog section consisting of five contacts for analog signals. The DVI interface accomodates a 12 or 24 pin DVI plug connector or a new type of analog plug connector that uses four additional pins, plus a ground plane plug to maintain constant impedance for the analog RGB signals.

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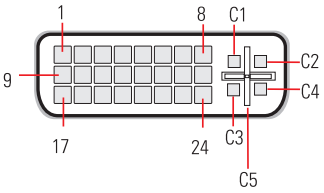
A DVI connector can only be inserted into the DVI interface. It cannot be plugged into the analog interface. Likewise, an analog plug connector cannot be inserted into a DVI interface without the supplied DVI/VGA adapter.

Pin assignment

The *ELSA GLoria DCC* offers the following assigment via a 29 pin port:



Pin	Signal assignment	Pin	Signal assignment
1	TMDS Data 2-	13	TMDS Data 3+
2	TMDS Data 2+	14	+5 V Power
3	TMDS Data 2/4 Shield	15	Ground (for +5 V)
4	TMDS Data 4-	16	Hot Plug Detect
5	TMDS Data 4+	17	TMDS Data 0-
6	DDC Clock	18	TMDS Data 0+
7	DDC Data	19	TMDS Data 0/5 Data0/5 Shield
8	Analog Vertical Sync	20	TMDS Data 5-
9	TMDS Data 1-	21	TMDS Data 5+
10	TMDS Data 1+	22	TMDS Clock Shield
11	TMDS Data 1/3 Shield-	23	TMDS Clock+
12	TMDS Data 3-	24	TMDS Clock-
C1	Analog Red	C2	Analog Green
C3	Analog Blue	C4	Analog Horizontal Sync
C5	Analog Ground (analog R,G, & B return)		

TMDS = Transition Minimized Differential Signalling

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7 Appendix

7.1 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 following procedures were applied during conformity testing:

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 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.

7.1.1 European Council (CE)

The declarations of conformity for the CE standard of the European Union are available for download on the ELSA web site (www.elsa.com/download).

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7.2 Federal Communications Commission (FCC)

ELSA AG GLoria DDC

FC Tested To Comply With FCC Standards

FOR HOME OR OFFICE USE

Compliance Information Statement
(Declaration of Conformity Procedure)

Responsible Party:	ELSA Inc.
Address:	1630 Zanker Road San José, CA 95112 USA
Phone:	+1-408-961-4600
Type of Equipment:	Graphics Board
Model Name:	GLoria DDC

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, May 29th 2001

Stefan Kriebel
VP Engineering
ELSA AG, Germany

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7.3 Warranty conditions for Europe

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. 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 back-ups 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.

7.4 Warranty conditions for North America

ELSA'S SIX YEAR LIMITED WARRANTY

ELSA provides the following limited warranty to purchasers of ELSA products within the United States, and ELSA's warranty obligations are limited to the terms set forth below:

a) ELSA AG and ELSA Inc. (jointly "ELSA") warrant this ELSA product and its parts (jointly "Product") against defects in material and workmanship for a period of SIX (6) YEARS from the date of delivery of the Product by an ELSA dealer to the purchaser.

b) ELSA's entire liability and Customer's exclusive remedy will be, at ELSA's sole discretion, the repair, replacement, replacement by a successor product or refund of the original purchase price of the Product not meeting ELSA's limited warranty if the Product is returned within the warranty period with a copy of proof of purchase, such as the original purchase receipt, to ELSA or ELSA's dealer. ELSA will not be responsible for shipping or handling

charges involved in shipping the Product to and from ELSA or ELSA's dealer, and purchaser must prepay all shipping charges.

c) ELSA will not be responsible for replacing Product that is damaged by:

   i) Accident, abuse, misapplication, mishandling, alteration, electrical current fluctuations, incompatible hardware or software, improper installation or operation, or improper packaging while the Product is in the possession of the purchaser,

   ii) The purchaser's failure to follow operating, maintenance, storage, or environmental instructions as set forth in the Product manual and specifications.

d) The warranty also does not apply if purchaser has submitted the Product for opening, modifications or repairs to persons other than ELSA or an authorized ELSA dealer.

e) ANY IMPLIED WARRANTIES ON THE PRODUCT, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE EXPRESS LIMITED WARRANTY PERIOD OF SIX (6) YEARS AS SPECIFIED ABOVE.

f) THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. ELSA DOES NOT WARRANT THAT THE PRODUCT WILL MEET CUSTOMER'S REQUIREMENTS, OR THAT THE OPERATION OF THE PRODUCT WILL BE UNINTERRUPTED OR ERROR-FREE. FURTHERMORE, ELSA DOES NOT WARRANT OR MAKE ANY REPRESENTATIONS REGARDING THE USE OR THE RESULTS OF USE OF THE PRODUCT OR RELATED DOCUMENTATION IN TERMS OF THEIR CORRECTNESS, ACCURACY, RELIABILITY, OR OTHERWISE. NO ORAL OR WRITTEN COMMUNICATIONS BY ELSA OR ELSA'S AUTHORIZED DEALERS OR REPRESENTATIVES SHALL CREATE A WARRANTY OR IN ANY WAY INCREASE THE SCOPE OF THIS WARRANTY. (SOME STATES DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES. THEREFORE THE ABOVE EXCLUSION MAY NOT APPLY TO YOU).

g) NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED HEREIN, ELSA ENTITIES SHALL NOT, UNDER ANY CIRCUMSTANCES, BE LIABLE TO PURCHASER FOR CONSEQUENTIAL, INCIDENTAL, INDIRECT OR SPECIAL DAMAGES RESULTING FROM BREACH OF WARRANTY OR ANY OTHER LEGAL THEORY, INCLUDING BUT NOT LIMITED TO DAMAGES ARISING OUT OF OR CAUSED BY ANY MALFUNCTION, DELAY, LOSS OF DATA OR PROGRAMS, LOSS OF PROFIT, INTERRUPTION OF SERVICE, DAMAGE TO OR REPLACEMENT OF EQUIPMENT OR PROPERTY, OR LOSS OF BUSINESS OR ANTICIPATORY PROFITS, EVEN IF ELSA OR ELSA DEALERS OR AUTHORIZED REPRESENTATIVES HAVE BEEN APPRISED OF THE LIKELIHOOD OF SUCH DAMAGES OCCURRING. ELSA SHALL NOT BE RESPONSIBLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT.

h) THIS LIMITED WARRANTY SHALL NOT EXTEND TO ANYONE OTHER THAN THE ORIGINAL PURCHASER OF THE PRODUCT OR THE PERSON FOR WHOM IT WAS PURCHASED AS A GIFT, AND STATES THE EXCLUSIVE REMEDY HEREIN.

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8 Glossary

- **3D** – Three-dimensional.
- **3D clipping** – A process within geometric transformation in which invisible areas or portions of a 3D object are removed.
- **3DNow!** – Extended command set used by AMD in the K6-2, K6-3 and K7 processors. 21 additional commands are intended above all to accelerate the floating-point operations that are especially important for 3D games.
- **3D pipeline** – The sum of all steps required in displaying an imaginary 3D scenario on the monitor. Included in this are ➟ Geometrical transformation and ➟ Refresh rate.
- **AGP bus** – Abbreviation for Accelerated Graphics Port—a relatively new interface standard within the PC platform. Graphics boards take advantage of its high transfer rates for the display of 3D and full-motion video sequences.
- **Aliasing** – The well-known staircase effect. There is often a jagged transition between adjacent pixels when displaying slanted or curved lines. The rough transitions can be smoothed using anti-aliasing.
- **Alpha blending** – Supplementary information per pixel for generating transparent material.
- **Anisotropic filtering** – Method designed to reduce texture aliasing effects on surfaces at an angle to the viewer. Unlike other methods (such as ➟ Bilinear filtering, ➟ Trilinear filtering) anisotropic filtering takes into account that such surfaces require a greater number of texture pixels for a clean display than surfaces that are perpendicular to the viewer. This especially enhances the legibility of text on angled planes ("Star Wars text").
- **Anti-aliasing** – Methods for the reduction of ➟ Aliasing effects.
- **API** – Application Programming Interface. Software interfaces that provide applications with complete packages of functions. The most important 3D APIs are ➟ Direct3D and ➟ OpenGL
- **Back buffer** – A portion of the graphics memory that is used to construct the image that is to appear on the monitor next. The back buffer is also used to calculate transparency effects.
- **Back-face culling** – Leaving out invisible areas.
- **Bilinear filtering** – In this case, a weighted average is calculated from four neighboring ➟ Pixels or ➟ Texels (2x2 matrix).
- **BIOS** – Abbreviation for basic input/output system. A code stored in the computer's memory (ROM), which carries out the self test and various other functions when the system is started.
- **Blitting** – Traditional method for ➟ Buffer swapping: the contents of the ➟ Bump mapping is copied to the ➟ Front buffer; slower than ➟ Page flipping.

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- **Buffer swapping** – The image prepared in the ➟ Bump mapping is displayed.
- **Bump mapping** – A technique that provides textures with depth information, which can be applied to display relief or embossed structures.
- **Bus system** – A system of parallel conductors for transferring data between individual system components, especially to expansion cards, such as ISA ➟ Page flipping and ➟ AGP bus.
- **Chrominance** – Color information in the transfer of video signals.
- **Clipping** – Reduces the number of ➟ Primitives to be calculated. All primitives outside the limits of the screen (2D) or outside of the ➟ Viewing pyramid (3D) are clipped or removed.
- **Cube environment mapping** – In order to represent realistic and undistorted reflections of the environment onto an object, six ➟ Textures are viewed as the surfaces of a cube. The textures show the environment from the perspective of the object. This gives the impression that the environment is being reflected by the object. CEM is an extension of sphere environment mapping. The advantage of CEM is that no new textures need to be calculated when the observer's point of view changes and the texture is not distorted.
- **D/A converter** – Digital/analog converter: A signal converter that converts digital input to analog output.
- **DDC** – Abbreviation for Display Data Channel. A special data channel through which a DDC-capable monitor can send its technical data to the graphics board.
- **DDR SDRAM** – Double Data Rate SDRAM is a further development of ➟ SDRAM memory technology. While SDRAMs only provide data at the actual system clock speed, DDR chips permit data to be accessed at twice the system clock speed.
- **Direct3D** – Software interface (➟ API) developed by Microsoft for the manipulation and display of 3D content.
- **DirectColor** – Method to achieve the high-resolution ➟ HighColor, ➟ TrueColor and ➟ RealColor graphics modes. In this case, the value stored in the video RAM (➟ VRAM) is not translated but is passed directly to the D/A converter ➟ D/A converter. This means that the full color information must be saved for each ➟ Pixel.
- **DirectDraw** – Software interface (➟ API) developed by Microsoft for the display of 2D content such as videos.
- **Double buffer** – Describes the presence of doubled display memory. This permits the next image to be generated first in the invisible background (➟ Bump mapping). As soon as it is completely constructed, the monitor display switches to the image that has been residing in the background and the preparation of the next image begins on the other side.

- **DPMS** – Abbreviation for ➟ VESA Display Power Management Signaling. This allows several stages of monitor power saving mode. The graphics boards described in this manual support VESA DPMS.
- **DRAM** – Abbreviation for Dynamic Random Access Memory. Dynamic random access memory with direct access.
- **EDO-RAM** – Abbreviation for Extended Data Output Random Access Memory (hyper page mode). EDO-RAM is especially advantageous in graphics boards because the most recently required data remains held in memory. Image rendering involves multiple consecutive read access of similar data, so EDO-RAM results in significantly faster speeds.
- **FCC** – The FCC radiation standard states that this device has been tested and meets the requirements for digital class B devices in accordance with section 15 of the guidelines as provided by the American Federal Communications Commission (FCC).
- **FIFO method** – Abbreviation for first in, first out: A system used in batch processing and queues, in which the first arriving signal is processed first.
- **Fixed-frequency monitor** – A monitor that can only be operated with at a specific resolution and refresh rate.
- **Flat shading** – ➟ Shading
- **Frame buffer** – Memory on the graphics board containing display information, especially the ➟ Front buffer and ➟ Bump mapping
- **Front buffer** – Refers to the visible image area in the case of ➟ Double buffer.
- **Full-scene anti-aliasing** – Describes a type of ➟ Anti-aliasing that is applied to a complete frame. Two processes are used in this form of anti-aliasing: Super sampling and Accumulated buffers. In the case of super sampling, a much higher resolution is calculated than the one to be displayed and then reduced. With the accumulated-buffer process, several views of a scene are drawn that are then combined to a single image.
- **Geometrical transformation** – The position of the objects in space is determined based on the observer.
- **Gouraud shading** – ➟ Shading
- **Graphics accelerator** – *ELSA GLoria DCC* is a graphics accelerator board that is especially well-suited for the user environment that requires intense graphics.
- **HighColor** – Stands for a graphic display mode with 15 or 16 bit color depth per pixel (32,768 or 65,536 colors).
- **Horizontal frequency** – The monitor line frequency (horizontal scan frequency) in kHz. This value must be set according to the monitor's requirements to prevent the monitor from being damaged in extreme cases!

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- **Horizontal scan frequency** – The monitor line frequency in kHz. This value must be set according to the monitor's requirements to prevent the monitor from being damaged in extreme cases!
- **Interpolation** – When displayed, video data must be stretched or shrunk to the correct window size. If the individual pixels are simply multiplied when stretched, unwanted blocks (the staircase effect, ➟ Aliasing) occur. This can be prevented using a filtering interpolation technique (averaging). While horizontal interpolation is easily accomplished, vertical interpolation is more complicated and requires buffered storage of the most recent image lines.
- **ISSE** – Extended Intel command set currently used in the Pentium III processors. 70 additional commands are intended above all to accelerate the floating-point operations that are especially important for 3D games.
- **Luminance** – Black/white information in the transfer of video signals.
- **MIP mapping** – MIP mapping assigns several textures with different resolutions to an object based on distance. If the observer gets closer to the object, the representation of the texture becomes more detailed.
- **MMX** – Extended Intel command set used by 166 MHz and higher Pentium processors bearing this designation. 57 additional commands accelerate especially integer operations.
- **Multifrequency (multisync) monitor** – A monitor that can be operated using different line frequency ranges and can adjust itself to different image signals (resolutions).
- **OpenGL** – 3D software interface (3D API). Such as implemented in Windows NT and optionally obtainable for Windows 95, this is based on Iris GL from Silicon Graphics and is licensed by Microsoft and ELSA.
- **Page flipping** – In the faster Page flipping method, only the buffer addresses are exchanged. The slower method (➟ Blitting) copies the contents of the ➟ Back buffer to the ➟ Front buffer.
- **PCI bus** – Abbreviation for peripheral component interconnect bus. A system of parallel conductors for transferring data between individual system components, especially to expansion cards.
- **Phong shading** – ➟ Shading
- **Pixel** – A picture element
- **Pixel frequency** – Pixel cycle frequency: The number of drawn ➟ Pixel per second in MHz.
- **PolygonOffset** – ➟ Z biasing
- **Primitive** – Simple, polygonal, geometric objects, such as triangles. In most cases, 3D landscapes are broken down into triangles.
- **RAM** – Abbreviation for Random Access Memory. Main memory and memory expansion in ➟ VRAM or ➟ DRAM depending on the graphics board.

- **RAMDAC** – On a graphics board, RAMDAC is responsible for converting digital signals into analog signals. VGA monitors can only process analog signals.
- **RealColor** – In general, stands for a 15 or 16-bit-per-pixel-wide graphic display mode (32,768 or 65,536 colors).
- **Refresh rate** – Indicates (in Hz) how often the image on the monitor is rebuilt per second.
- **Rendering** – The calculative process for representing 3D scenery, where position and color are determined for each point in space. The depth data are located in the ➟ Z buffer while the color and size data are in the ➟ Frame buffer.
- **Resolution** – The number of pixels in both horizontal and vertical directions (e.g. 640 horizontal x 480 vertical pixels).
- **RGB** – Color data stored in red/green/blue format.
- **ROM** – Abbreviation for Read Only Memory. Solid state memory that can be read from only.
- **S-video** – Or S-VHS. A method of transferring video data signals, where the signals for ➟ Chrominance and ➟ Luminance are separated. This results in improved image quality.
- **SDRAM** – Synchronous Dynamic Random Access Memory. These memory chips are based on standard DRAMs (➟ DRAM), but are fast enough to permit data access at the clock speed of the ➟ Bus system. This eliminates the wait states typical of DRAMs. They consist of two separate memory ranges, with one preparing data for access while the other is actually still being accessed.
- **Shading** – The shading of curved areas to make them appear as realistic as possible. To do so, the curved areas are divided into many small triangles. The three most important 3D shading methods differ by how the color gradients within the triangles are represented: Flat shading: The triangles are colored uniformly. Gouraud shading: The color gradient is determined by the interpolation of the corner color values. Phong shading: The color gradient is determined by the interpolation of the normal vector plus the calculation of the light incidence for each pixel. These shading methods are not supported directly in the standard OpenGL API.
- **Single buffer** – Unlike the ➟ Double buffer, where there is doubled display memory, single buffer mode does not allow access to the next prepared image, resulting in animation that is not smooth.
- **Sphere environment mapping** – ➟ Cube environment mapping.
- **Stencil buffer** – This buffer permits the color information of the ➟ Pixel to be supplemented with further information. This can be used to create stencils, volumetric shadows and reflective surfaces, for example.
- **Strips and fans** – Process for the reduction of data volume required for complex 3D objects. Strips are used for objects consisting of several parallel rows of triangles. Rather than calculating each individ-

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ual triangle, the vertices are transferred only once. A fan object is used when several triangles converge to a single point. In this case, the vertices are also transferred only once. These processes can reduce the data volume by approximately a third.

- **Tearing** – If there is no synchronization with the monitor when switching between images (pages) in ➟ Double buffer mode, areas of the images can become offset. To resolve this, the switching between pages is synchronized with the monitor frequency (Wait on Vertical Blank).
- **Tesselation** – Tessellation subdivides objects into polygons (e.g. triangles) for 3D rendering. For these primitives, the corner point and color values as well as the transparency value if necessary are determined. Tessellation is currently performed by the application, i.e. upstream of the ➟ 3D pipeline.
- **Texel** – Individual pixel of a ➟ Texture.
- **Texture** – The overlaying of a surface with a texture with correction for perspective, such as a wood grain or the drawing of a wall with wallpaper in a perspective view. Videos, too, can be used as a texture.
- **Transformation & Lighting (T&L)** – Using T&L, the main computer processor is freed up from the consuming task of computing geometric calculations. This computational process, which includes all of the coordinates of a 3D object during rotation, shifting, scaling and color, is taken over by the graphics board processor.
- **Trilinear filtering** – This is a mixture of ➟ MIP mapping and ➟ Bilinear filtering.
- **TrueColor** – A graphic display mode with max. 16.7 million colors, i.e. a color depth of 24 or 32 bits per pixel.
- **VESA** – Abbreviation for Video Electronics Standards Association. A consortium for standardizing computer graphics.
- **Viewing pyramid** – Designation for the part of a 3D space located within the viewer's field of vision.
- **VRAM** – Abbreviation for Video RAM. A module for upgrading the memory on a graphics board to display higher resolutions and color depths.
- **Z biasing** – ➟ DDR SDRAM method for the correct display of various objects with the same depth coordinates. A typical example is the display of a shadow on a wall: both objects have the same Z (depth) coordinates, but the shadow must appear on the wall (not vice versa). The included Z bias value ensures the correct display. Under ➟ OpenGL, this functionality is called PolygonOffset.
- **Z buffer** – The 3D depth information of a pixel (the position in the 3rd dimension).

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