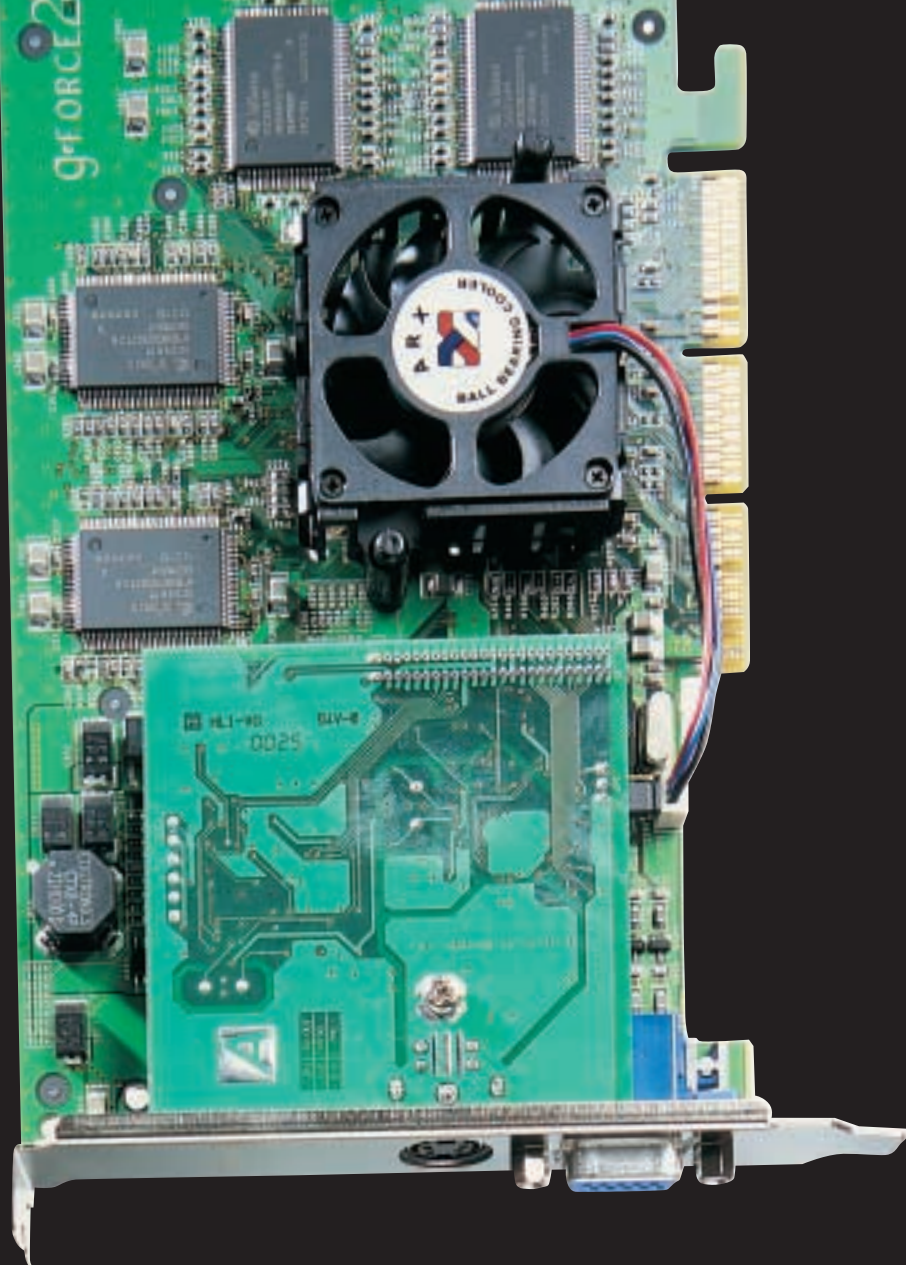
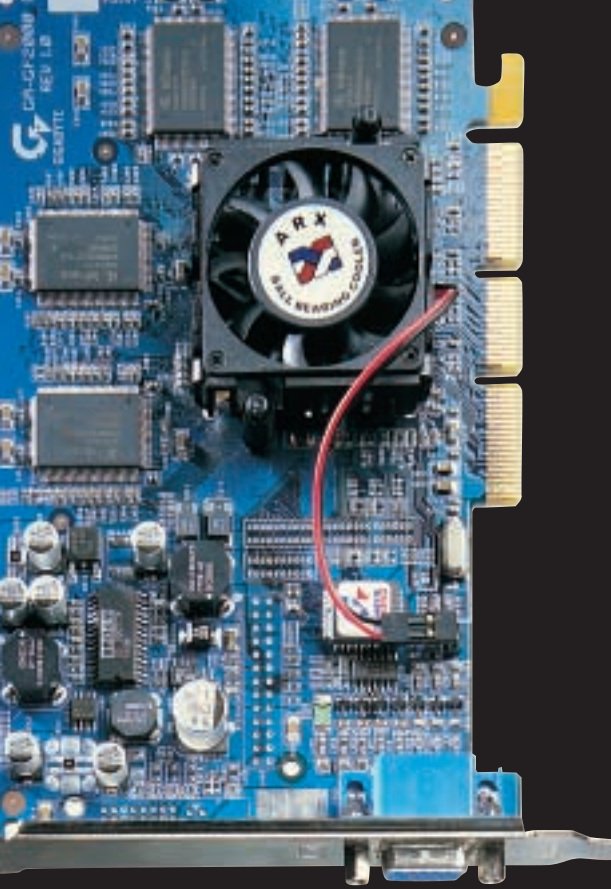


Pixel perfect



Gamers are always looking for the best and fastest graphics cards, so we took a look at 14 of the best around to see how well they performed under rigorous tests in our labs

Over the past few years and since our last group test back in December, graphics cards have undergone many changes. With the rendering process moving from the PC's CPU to the graphics card's GPU (graphics processing unit) together with increases in memory size, these cards have now become very desirable upgrades – especially for the gaming enthusiast. This demand for top-quality graphics and 3D acceleration continues to be fuelled by the gaming community and has given rise to a very competitive market akin to the one being thrashed out between PC processor manufacturers.

One of the main players in this field is nVidia and its release of the GeForce 256 GPU last year heralded a new era in graphics card technology. The card had its own T&L (Transform & Lighting) engine that ultimately took load away from the CPU. Barely six months later, and in true Intel/AMD style nVidia released the GeForce2 GTS chipset to supplant the older card. This runs faster and cooler, and has been incorporated into many of today's graphics boards. However, nVidia is not alone, with the likes of ATI and 3dfx producing cards based solely on their own chip designs.

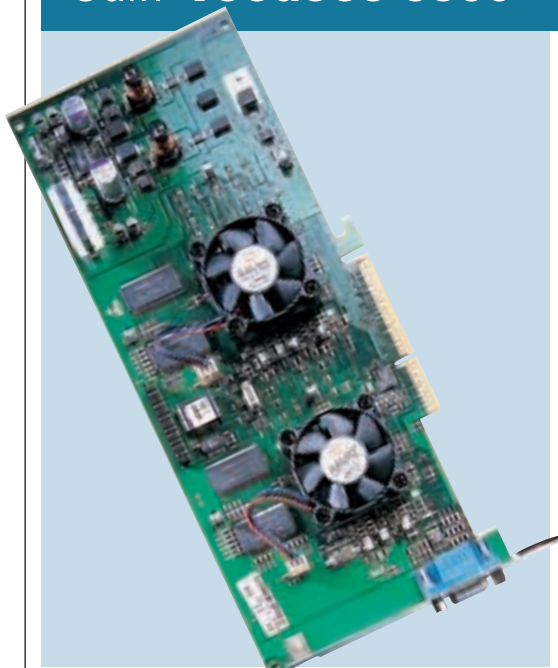
So, to find out who has made the best use of nVidia's technology, and to see how the independent contenders fair, PCW has rounded up 14 of the best and latest cards and challenged each to run our gauntlets.

contents

- 196** 3dfx Voodoo5 5500
AOpen PA256 Deluxe
- 197** Asus V7700 Deluxe
Asus V7700 Pure
- 199** ATI All-In-Wonder 128 Pro
ATI Radeon
- 200** Creative 3D Blaster
GeForce2 GTS
ELSA Gladiac GeForce2
GTS 32MB
- 202** ELSA Gladiac GeForce2
GTS 64MB
Gigabyte GA-GF2000
- 203** Hercules 3D Prophet II 32MB
Hercules 3D Prophet II 64MB
- 204** Matrox Millennium G400 Max
MSI MS-StarForce 815
- 205** FSAA explained
- 206** How we did the tests
- 208** Performance results
- 210** Features table
- 213** Editor's Choice

• Graphics cards tested and reviewed by Riyad Emeran, Scott Montgomery and Jalal Werfalli

3dfx Voodoo5 5500



WHEN WE LOOKED at the full retail release of the Voodoo5 5500 last month we had warmed to it a little since the initial preview the previous month. That said, it's only when the Voodoo is up against a full range of its peers that its inadequacies become truly evident.

Performance results show it languishing near the bottom of almost every graph. When we first heard about the Voodoo5 at Comdex last November we were expecting it to wipe the floor with its peers, due to its dual-chip configuration, but unfortunately it didn't live up to expectations. 3dfx has also chosen not to equip the Voodoo5 with either transform and lighting (T&L) or hardware environment bump mapping features.

What 3dfx has equipped the Voodoo5 with is full scene anti-aliasing (FSAA), which basically blurs the edges of polygons to make 3D models have smoother curves. There are, however, a couple of problems with this

feature. First, the performance takes a serious hit when the FSAA is applied and second, both the GeForce2 and the Radeon chipsets also support it. That said, the FSAA on the Voodoo does look very good, especially on games such as Tomb Raider, and the Voodoo has the

added advantage of having the largest back catalogue of 3D titles due to the proprietary 3dfx GLide API. This means that you could go back and play the first Tomb Raider episode with superior graphics, should you want to.

As well as the two VSA-100 chips, there's also 64MB of memory and a power socket. This board draws so much power that the AGP slot alone can't supply it with enough so it has to be connected directly to your power supply. This board is absolutely huge, so make sure your drive cage won't get in the way before you buy.

Ultimately, the Voodoo5 can't compete on performance, but if you want to get the best from your back catalogue games it's worth considering.

DETAILS

★★★★

PRICE £210.32 (£179 ex VAT)

CONTACT dabs.com 0800 138 5154

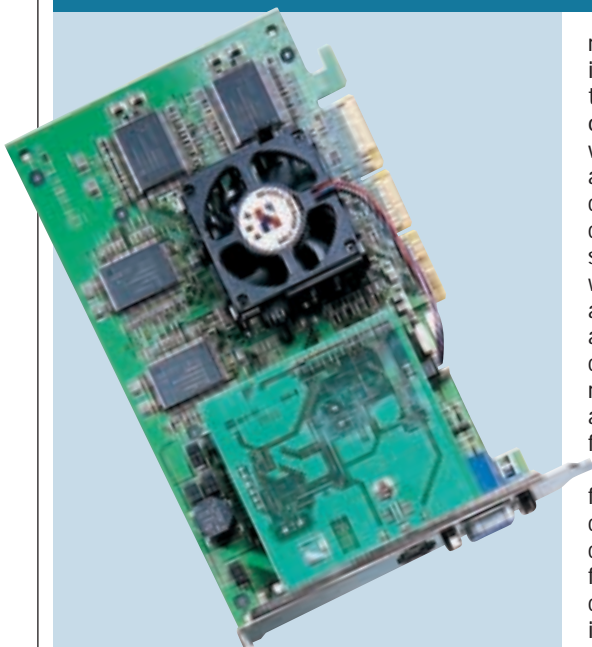
www.3dfx.com

PROS Reasonably cheap, good backward compatibility

CONS Poor performance, lack of features

OVERALL The Voodoo is eclipsed by the competition that has better performance and more features

AOpen PA256 Deluxe



THE AOPEN PA256 Deluxe was the easiest of all the cards tested to install. Most were fairly simple, but the AOpen involved only one click, then all the relevant software is transferred to your system, saving you the trouble of trawling the CD for drivers, which some cards

required. The software also includes an OpenGPU utility that displays the temperature of your card, along with voltages across the memory and GPU, as well as the fan's current speed. For the compulsive overclocker, this same utility can be used to wind the frequency of the core and memory up to 255MHz and 450MHz respectively. The card is set to nVidia's recommended 200MHz core and 333MHz memory frequency.

Trying out the utility we found a few extra frames could be sucked out of the card by increasing the frequencies by around 10 per cent; any higher than this and it became unstable. You can also get quick access to the

card's BIOS during POST (Power On Self Test), by pressing the Insert key. This allows you to reduce the overlocking before the operating system boots, if you've pushed it beyond its limits.

AOpen has gone for a conventional green PCB look. A riser board sits above

the main card, with the hardware for the S-Video socket built into it. The 32MB of SGRAM sits on both surfaces.

The AOpen's performance was among the best, regularly beating all but the 64MB GeForce2 cards, and with 28.5fps in Quake III at 1,600 x 1,200 with 32bit colour and textures, it's only marginally behind the ELSA Gladiac 64MB which managed only 28.7fps at the same resolution and colour depth.

With its easy install, a copy of InterVideo's WinDVD 2000 and a couple of games, the AOpen PA256 Deluxe is an excellent card. If you want to play Quake III with a GeForce2 card, and want it to look its best, this is worth a look.

DETAILS

★★★★

PRICE £249 (£212 ex VAT)

CONTACT Majestic Technologies

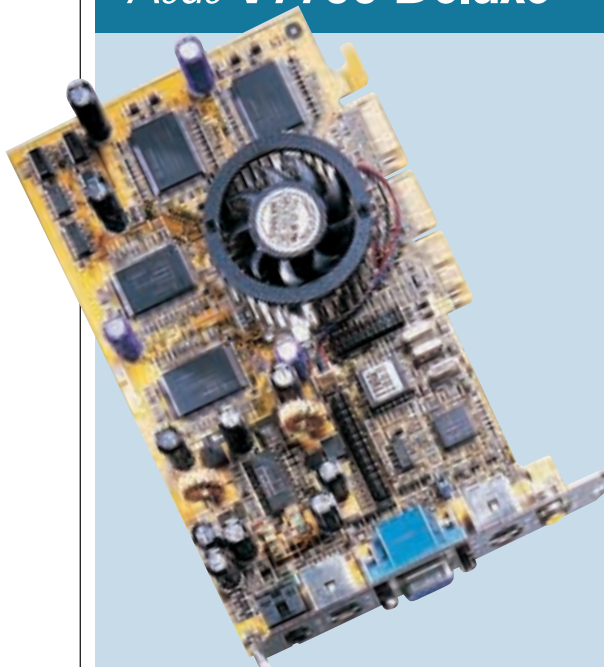
0845 6000 144 www.aopen.nl

PROS Excellent performance from a 32MB card

CONS More expensive than other 32MB models

OVERALL This card is one of the best performing 32MB cards in the test. With a good software bundle and TV-out, you could do a lot worse

Asus V7700 Deluxe



BASED ON THE V7700 (below), this Asus all-round multimedia card comes with a variety of outputs that extend its versatility. These include composite and S-Video out ports as well as an S-Video in port and it has all the necessary S-Video and composite leads to get you

up and running straight away.

Carrying on the tradition of its 'Deluxe' cards, Asus has included its 3D glasses that are meant to create a virtual reality environment for gameplay. We were not impressed as the 3D effect is minimal and makes on-screen text difficult to resolve.

The board has the same cosmetic circular fan as the V7700 Pure, bordered by the DDR SGRAM memory chips. These equate to a total of 32MB, running at two times 166MHz – typical of most of the nVidia GeForce2 GTS boards. The GPU core is clocked at 200MHz with the option of increasing this to 220MHz using the bundled Tweak Utility. Using the same tool the memory frequency

can be pushed to 364MHz if you dare.

In terms of performance, the V7700 Deluxe put in excellent scores in most of the tests. At a resolution of 1,280 x 1,024 with 16bit colour the card ranked third with a 3DMark score of 4,906. Elevating the resolution to 1,600 x 1,200

in 16bit, put the Deluxe in fourth place with a score of 3,702. As for Quake III the V7700 Deluxe did not fall beyond fifth place at all the settings, with frame rates of 77.5 and 27.3 for 1,280 x 1,024 in 16bit colour and 1,600 x 1,200 in 32bit colour, respectively. Test Drive 6 frame rates are adequate apart from the fail in the 1,600 x 1,200 at 16bit test, and the flickery 22fps at 32bit.

Driver installation went smoothly and you get a good selection of software. The card also comes with Asus Live Utility to view and capture video from the video input port.

Rather than appealing to the full-on gamer who wants a decent level of refreshing frames with great detail, this card will find a different market. You pay a premium for the extra features though.

DETAILS

★★★

PRICE £284 (£243 ex VAT)

CONTACT Ultimate Hardware

0845 1000 170

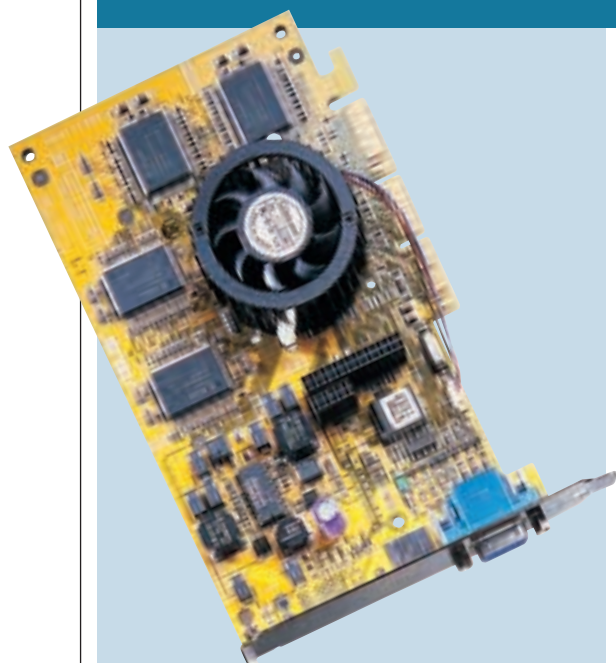
www.ultimate-hardware.co.uk

PROS A decent and versatile performer

CONS Relatively expensive

OVERALL A good set of features for the video enthusiast, or those concerned with security

Asus V7700 Pure



ASUS, POPULARLY known for its motherboards, was one of the first manufacturers to utilise the nVidia GeForce2 GTS chipset in a retail graphics board. The no-frills design of the Asus V7700 Pure is very similar to nVidia's reference card we previewed back in July.

The GeForce2 consumes less power and therefore produces less heat than the original GeForce. This suggests that the circular heatsink on the V7700 is more cosmetic, rather than offering any extra cooling over a standard square heatsink.

Like most of the other GeForce2-powered cards here, the core of the GPU on the V7700 is clocked at 200MHz, while the 32MB of DDR memory runs along at 333MHz. In 3DMark at 1,280 x 1,024 with 16bit colour, the V7700 scored an adequate 4,843, which ranks this card in ninth place. Like all the other 32MB GeForce2 cards tested this month, the V7700 failed to complete the 3DMark test at 1,600 x 1,200 with 32bit colour.

Upgrading to the latest drivers when they are released may resolve this. In the Quake III tests at 1,280 x 1,024 with 16bit colour, the card scored 76.2fps placing it slap bang in the middle of the group. The V7700 also came top with a

very respectable 73fps in Test Drive 6 at the same resolution settings.

Although this model lacks the variety of outputs seen on the V7700 Deluxe, you have the option of adding a TV-out module at a later date. For software, Asus has included SmartDoctor and Tweak Utility, allowing you to monitor and adjust such hardware settings as fan speed and cooling, overclocking, overheating, and the AGP power level. Asus DVD2000 and a games package are also bundled so that you can watch DVDs and begin gaming on your PC.

At £269.07 inc VAT this GeForce2 model is a little overpriced and for the extra money you do not get any extra features. For a little more cash, you could go for either of the two Editor's Choices.

DETAILS

★★★

PRICE £269.07 (£229 ex VAT)

CONTACT dabs.com 0800 138 5144

www.dabs.com

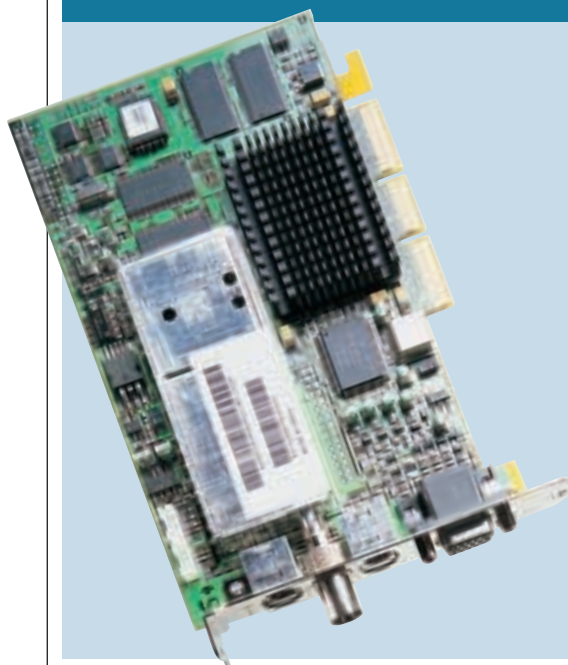
PROS The chipset and software utilities

CONS Expensive; no hardware features

OVERALL A middle-of-the-road graphics card that neither shone nor under-performed – difficult to recommend because of the price



ATi All-In-Wonder 128 Pro



Although it is not the fastest 3D card in the world, when it comes to connectivity, it is a high-quality offering that is cheaper than the Asus V7700 Deluxe, which has similar features.

Based on ATi's Rage 128 Pro chip, the name All-In-Wonder is no misnomer when the possibilities for connectivity are considered. Not only does it have a multitude of input/output options (including S-Video and composite out), but cables are also supplied to ensure you have everything included in the box to attach your video peripherals.

With ATi cards known for quality DVD playback due to their excellent motion compensation, the All-In-Wonder removes the need to buy a separate MPEG2 decoder. This second card is usually required to gain the level of high-quality DVD playback achieved as standard with ATi cards, and as all the cabling is included to connect your PC to your TV (and with inclusion of a

INCLUSION OF THIS card from ATi may seem misplaced in what is a group test of fast gaming cards. That it is included is testament to its versatility and its niche in the video card market. It is an ideal solution for those interested in playing DVDs or editing video.

3.5mm audio jack to stereo phono converter, to connect your sound card to your hi-fi), this is an ideal solution for you to turn your living room into an incredible home theatre. There's even a built-in TV tuner, complete with Teletext thrown into the bundle.

Admittedly, at the resolutions we were testing, the performance wasn't wonderful for 3D gaming. But then if you don't mind playing Quake III at 1,024 x 768 in 16bit, it will be more than adequate. If your main concern is video editing or DVD viewing, though, this card is ideal. Cheaper than most of the other entrants, the ATi All-In-Wonder 128 Pro is excellent value and extremely versatile.

DETAILS

★★★★★

PRICE £169.20 (£144 ex VAT)

CONTACT dabs.com 0800 138 5154

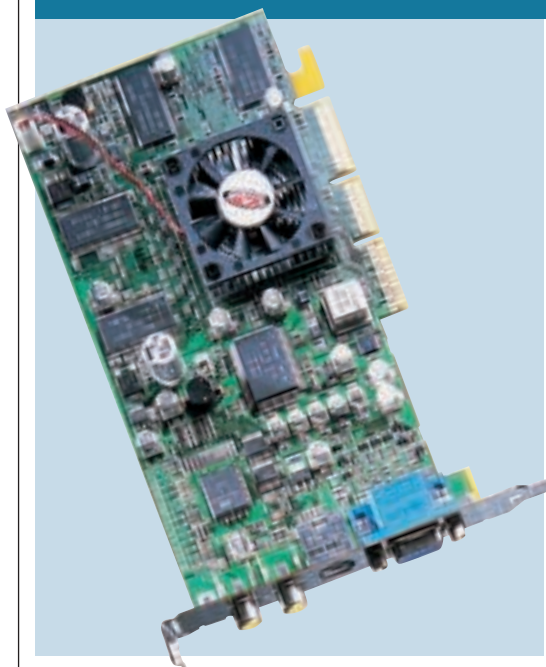
www.dabs.com

PROS Incredibly versatile card ideal for those with an interest in DVD and video editing

CONS Not a gaming card

OVERALL Overall If gaming is not your thing, then the All-In-Wonder is an excellent card for everything else you might want to do with your PC and video

ATi Radeon



ATi has come up with a cutting-edge graphics chipset, but the Radeon is a step in the right direction.

The original spec was for a 200MHz chip speed with corresponding 200MHz DDR memory, doubling up to 400MHz. Unfortunately a lack of fast DDR memory has resulted in the production Radeon boards sporting a 183MHz chip with 64MB of 183MHz DDR memory doubling up to 366MHz. This puts the processor speed 17MHz behind the GeForce2 chip, but the memory speed 33MHz ahead.

Performance-wise the Radeon couldn't keep up with the GeForce2 cards in 16bit colour, but switching to 32bit colour saw the

WE PREVIEWED the ATi Radeon in August when it looked like ATi was about to pull something very special out of the bag. The production card proves that our initial reaction was justified and that ATi has produced a very impressive graphics solution. It's been a while since

Radeon rising to the top of the performance chart. The GeForce2 chipset has more raw horsepower due to its four pipelines as opposed to two on the Radeon. ATi could have equipped the Radeon with four pipelines, but decided to increase its feature set.

Like the GeForce2, the Radeon has an integrated T&L engine to offload geometry calculations from the CPU and leave it free for other duties. However, unlike many other cards currently available, the Radeon also supports hardware environment bump mapping. This creates far more lifelike surfaces without the need for massive polygon counts, but like T&L we're waiting for games to take full advantage of it.

As well as the most comprehensive 3D feature set, the Radeon also sports video in and video out (VIVO) capabilities, so you can use it for video editing as well as playing games. The ATi is good value, and has great features and 64MB of the fastest graphics memory around.

DETAILS

★★★★★

PRICE £299 (£254.46 ex VAT)

CONTACT ATi 01628 533 115

www.ati.com

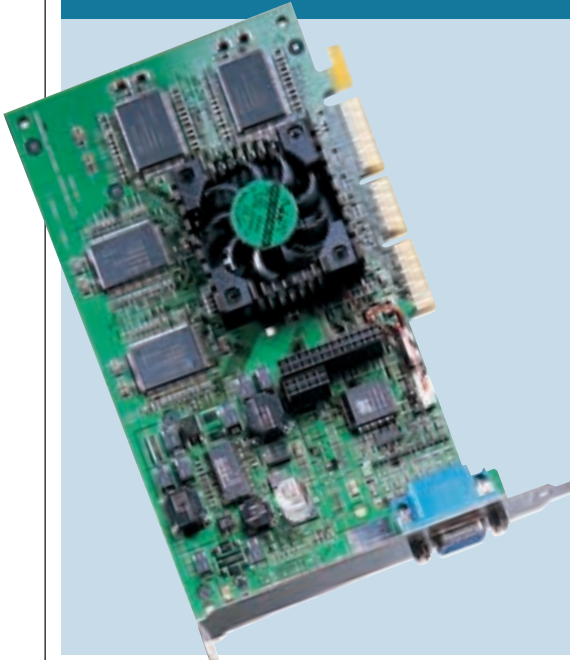
PROS The most feature-rich graphics card available

CONS Not as fast as the GeForce2 in 16bit colour

OVERALL A superb card from ATi, every feature you could want and 64MB of memory



Creative 3D Blaster GeForce2 GTS



THE 3D BLASTER is one of the cheapest 32MB versions of nVidia's new chipset at £215.02 inc VAT. This means it takes advantage of the 0.18micron die process, rather than the 0.22 process of the original GeForce. As with the other cards here this allows the GPU to run at

the higher clock speed of 200MHz. Curiously, the Creative's default setting was found to be 199MHz, and unlike the other graphics boards, it didn't have an overclocking facility. The memory nevertheless can be pushed up to 366MHz.

Driver installation was a slightly lengthy process with the option of installing Sonnetech's Colorific together with 3Deep to help you adjust the colour and display more accurately. BlasterControl 4.0 allows you to add shortcuts to the BasterControl interface, run the card in safe mode, and set the colours and refresh rate. It also gives info on the drivers and BIOS. You can also diagnose your

card and adjust the OpenGL and Direct3D settings.

As far as performance goes the 3D Blaster GeForce2 is much the same as the other cards with the same chipset and quantity of SGRAM. It scored 4,852 in the 3DMark test at a resolution of

1,280 x 1,024 in 16bit colour. As for frame rates at this setting the Creative managed 74.9 for Quake III and 69 for Test Drive 6. Moving on to 32bit colour and the story is much the same as the rest of the 32MB GeForce2 field with no results for 3DMark at 1,600 x 1,200 in 32bit colour. The fact that the Creative wasn't the only GeForce2 card to fail in Test Drive 6 at 1,600 x 1,200 with 16bit colour, suggests that it may be driver related. We would recommend installing the latest drivers for all of these when they become available.

What the Creative lacks is any form of extra outputs other than the standard D-SUB connector. On the surface, there are sockets for an S-Video output board, but this is not part of the package.

DETAILS



PRICE £215.02 (£183 ex VAT)

CONTACT dabs.com 0800 138 5154

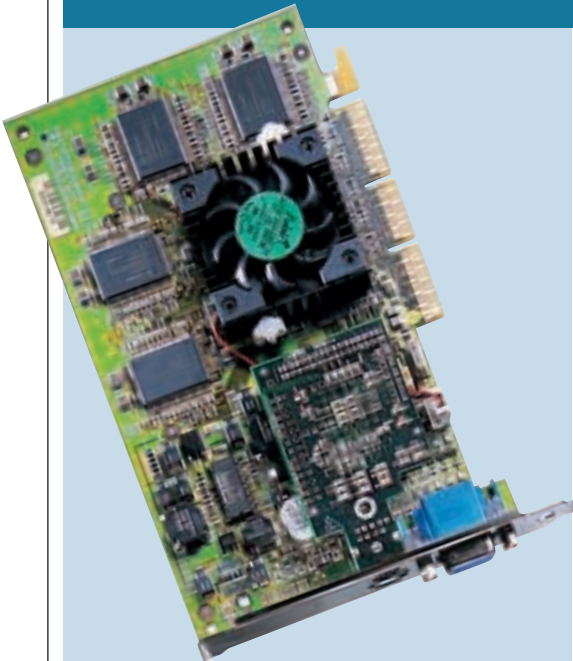
www.europe.creative.com

PROS A well-priced GeForce2 GTS graphics board

CONS No outputs and no option to overclock memory with supplied driver

OVERALL A cheaper option to get your hands on nVidia's latest graphics technology

ELSA Gladiac GeForce2 GTS 32MB



ELSA MAY NOT BE the best known graphics card manufacturer in the UK, but in Europe it's one of the most prevalent. ELSA used to be best known for its high-end graphics workstation cards costing well over £1,000. These were the forerunners of the now

commonplace T&L enhanced graphics cards, where much of the geometry calculation is taken away from the CPU to enhance overall performance.

ELSA's recent less exotic graphics cards have the latest chipset from nVidia, the GeForce2 GTS. This very advanced chipset features an integrated T&L engine and allows multiple textures per pixel, but it doesn't support hardware environment bump mapping, so you won't get the incredibly realistic textures that the ATi Radeon can achieve. This version of the Gladiac sports 32MB of RAM although a 64MB version is also available with a price premium attached.

Even though this card has only half the memory of its

bigger brother, it does have a feature that its sibling lacks. As well as the standard D-SUB monitor connector there is also a video input/output connector. This small din plug connects to a supplied cable which offers S-Video in and out ports. This is a pretty good

addition as this is one of the cheapest GeForce2 cards on test.

The 32MB Gladiac took fourth place in the 3DMark test at 1,280 x 1,024 in 16bit colour, although most of the GeForce2 cards produced similar scores. In all the tests the Gladiac was no better or worse than the majority of similarly specced cards.

If you want to buy a 32MB GeForce2 card, there's not too much between them as far as performance goes. What you should consider is any extra features and how much they cost. The Gladiac scores well on both these counts, it has the extra video in and out feature and sports one of the lowest prices on test.

This is a great graphics card offering a cutting-edge chipset and added video functionality at a reasonable price.

DETAILS



PRICE £216.20 (£184 ex VAT)

CONTACT dabs.com 0800 138 5154

www.elsa.co.uk

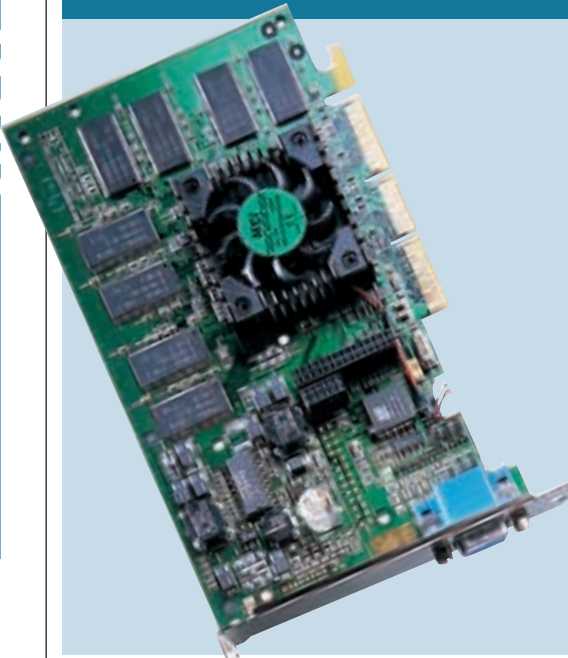
PROS GeForce2 chipset, video in/out, reasonable price

CONS Faster cards available

OVERALL A good card with a solid price/performance ratio



ELSA Gladiac GeForce2 GTS 64MB



ELSA WAS ONE OF the first vendors to release a graphics card based on the GeForce2 GTS chipset and 32MB of DDR SGRAM. This month, the company has gone one step further with the release of the Gladiac GeForce2 GTS 64MB. Based on a GPU core running at

the standard 200MHz, the Gladiac is one of four boards in this test that sport a whopping 64MB of memory.

At a resolution of 1,280 x 1,024 in 16bit colour, the card scored pretty much the norm with 4,783 in the 3DMark test. The effectiveness of the Gladiac's extra memory is shown in our tests, since it was one of the few cards that was able to record a result in 3DMark at 1,600 x 1,200 in 32bit colour. If the resolution or the colour depth is bumped up the ELSA rises towards the top of the field in all the tests. It also hits top in the Test Drive test at both 1,280 x 1,024 and 1,600 x 1,200 in 32bit. The Gladiac 64MB is, however, overshadowed by the Hercules 3D Prophet II in the 3DMark tests. The Quake III scores paint a similar picture. At a resolution of 1,600 x 1,200 in 16bit colour, the Gladiac manages 54.1fps – second to the 64MB Hercules card, one of the Editor's Choices. ELSA hasn't included video in/out

functions on the Gladiac GeForce2 GTS 64MB – features that are included on the 32MB version. Bundled software includes a DVD player, while overclockers will be able to tweak the memory from 320 to 380MHz and the GPU core from 180 to 240MHz. Be careful though, as unlike the 64MB 3D Prophet II no heatsinks are present on the memory chips.

In terms of raw power, the Gladiac is not the fastest in this test, but the frame rates it achieves are more than enough for the current crop of games. Even though the Gladiac comes into its own when higher resolutions are important, it's unlikely that the majority of users will benefit from the extra memory, apart from the true gaming junkie.

At the time of going to press, ELSA could not give us a price. Therefore, we are unable to give the card a star rating.

DETAILS

N/A

PRICE Not supplied

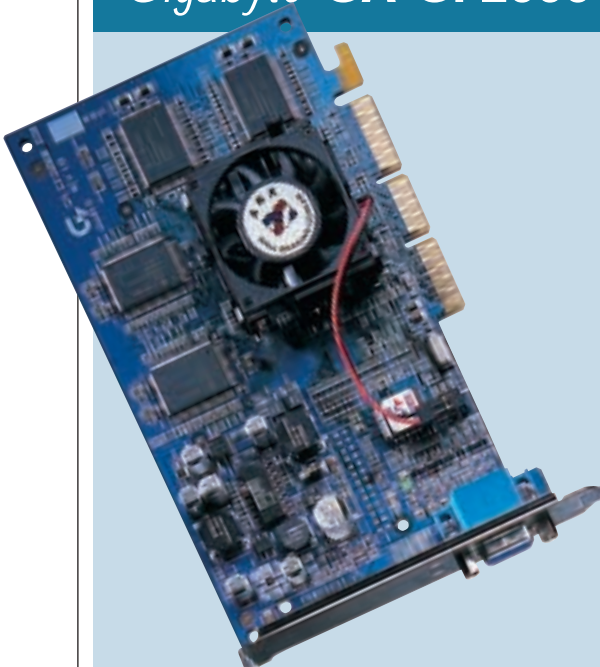
CONTACT www.elsa.co.uk

PROS Excellent results at higher resolution and colour-depth settings

CONS Video outputs are optional extra

OVERALL A card that performs well at high settings but isn't strong on features

Gigabyte GA-GF2000



MORE ASSOCIATED with motherboard manufacture, Gigabyte has turned to graphics cards with the GeForce2-driven GA-GF2000. The board is blue in colour, but is otherwise unspectacular-looking. As with most GeForce2 cards it has 32MB of onboard DDR SGRAM and

a fan over the GPU to keep things cool as it pumps along.

Of all the cards employing the GeForce2 chipset, the GA-GF2000 is not the fastest, with an average position around seventh place. Its strongest performance was in the Test Drive 6 demo at 1,600 x 1,200 in 32bit colour, where it achieved a respectable fourth place with 22fps, which is an admirable score for such a demanding resolution and colour depth. Strangely, its poorest performance was in 3DMark 2000 at 1,600 x 1,200 with 16bit textures and colours where it came tenth (and last among the GeForce2 cards).

The GA-GF2000 was unable to run 3DMark at 1,600 x 1,200 in 32bit, as were

all the cards employing the GeForce2 chipset coupled with 32MB of SGRAM. In fact, of the GeForce2 cards, only the 64MB versions could run this test

For the overclocking enthusiast, this card has sliders in the software drivers allowing the core to be overclocked

from its recommended 200MHz to 220MHz, and the memory from 333MHz to 370MHz. Although overclocking the core has little effect, bumping up the memory frequency gives a few extra frames, although we wouldn't recommend it as the memory runs fairly hot on all GeForce2 cards at the recommended frequencies, and overclocking may reduce the life of the card.

For gaming, this card is easily as good as any of the others available. The bundled drivers are based on nVidia's reference drivers 5.30, and so are right up to date and utilise all the card's features. However, with no added extras on the card to recommend it, the Gigabyte GA-GF2000 doesn't represent the best value in this test.

DETAILS

★★★

PRICE £239 (£203.40 ex VAT)

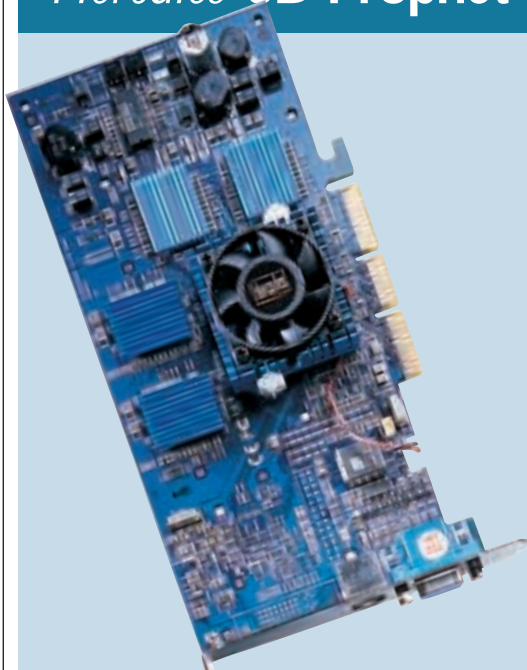
CONTACT Gasteiner Technologies
020 8345 6000 www.gasteiner.com

PROS It's fast, but not the fastest

CONS Not the best of the no-frills GeForce2s

OVERALL A perfectly good GeForce2 card, although there are some alternatives that get more from the chipset

Hercules 3D Prophet II 32MB



Looking like a sleeker version of the 64MB card, the 32MB board is blue, quite large and has blue heatsinks over the DDR SGRAM chips, four on the upper surface and four on the lower. The heatsink over the GPU is of a similar blue to the others, giving this card excellent overall looks.

The Prophet's memory runs at 333MHz, but can theoretically be clocked up to 420MHz. The heatsinks will be of use if you choose to overclock it, helping to dissipate the heat generated by the memory chips over a larger surface area. The core runs at 200MHz as recommended by nVidia, but can be clocked up to 250MHz for those who dare. Although

THE 32MB VERSION of the Hercules 3D Prophet II may seem overshadowed by its 64MB big brother, but its performance in the tests showed that it is still a good contender – and that's without the overclocking the 64MB uses to burn its way to the top of most of the tables.

the sliders in the software go up to these higher frequencies, this does not mean the card will run at these speeds, it's more likely that it will just lock up.

The 32MB Prophet II performed well at all resolutions in 16bit. Not the highest of the 32MB cards in any test,

but neither is it the worst performer. Its best performance was at 1,600 x 1,200 in 16bit colour in Quake III and the Test Drive time demo, where it came sixth and fourth respectively; and since most of the cards that beat it were 64MB versions, this is fair performance.

The card comes with an S-Video socket complete with a composite converter if you don't have S-Video on your TV. Power DVD software is included so you can play DVD movies through the card to your television.

With its performance as good as most other GeForce2 cards, and a DVD player and TV-out as standard, the Prophet II 32MB may not be the ultimate card its 64MB counterpart is, but it does offer good value.

DETAILS



PRICE £246.74 (£209.99 ex VAT)

CONTACT Jungle.com 0800 0355 355

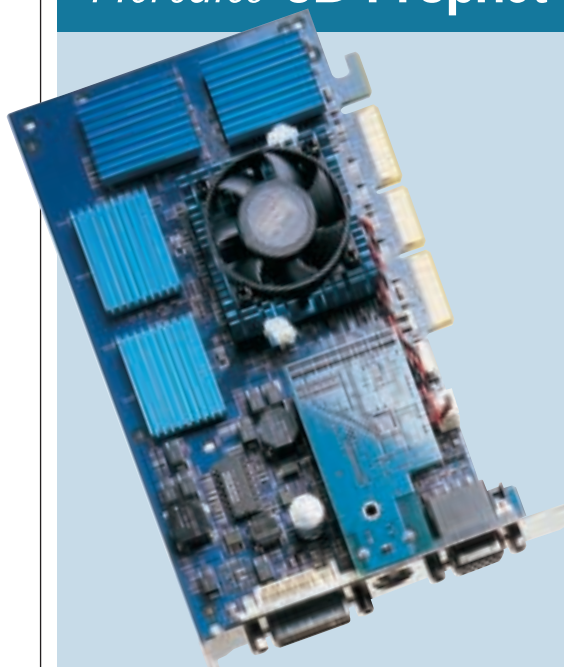
www.hercules.com

PROS With heatsinks to keep the memory cool, this card is not only functional, but it looks great too

CONS Not one of the fastest card on test

OVERALL Good performance and value from a card with S-Video out and a DVD player

Hercules 3D Prophet II 64MB



is it so hot? Because as standard, the drivers supplied by Hercules overclock both the memory and the GPU core of the 64MB Prophet II. So instead of nVidia's recommended 200MHz core and 333MHz memory, this card runs a 220MHz core and 365MHz memory – and it flies.

The overclocking may have implications for the longevity of the card. However, the presence of the heatsinks over the memory ensure as much heat is dissipated as is physically possible. Besides, in the extensive testing we put the card through we found it remained stable despite the high temperature, only crashing once (and that

HERCULES' 64MB 3D Prophet II is one hot card – literally. If you were a very small person, with some very small burgers, you could have a fair go at cooking them on the heatsinks that cover the 64MB of DDR SDRAM, such is the heat generated by this monster. Why

wasn't even during a test). Hercules has gambled on overclocking, and it appears to have paid off; and what's more, if you don't want it running hot, all you need to do is use the utility to return the frequencies to the recommended levels.

So how fast is it in its standard

configuration? In 16bit colour and textures in 3DMark 2000, at 1,280 x 1,024 and 1,600 x 1,200, it topped the tables with scores of 5,145 and 4,050 respectively. At 32bit colour, at the same resolutions, the ATI Radeon was the only card to beat it. In the Quake III tests it achieved a blistering 81.8fps at 1,280 x 1,024 at 16bit, zipping through the time demo at an incredible rate.

With Power DVD software and DVI and S-Video out sockets as standard, this is the fastest GeForce2 card we've seen. Hot it may be, but if you're looking for a card to make your graphics burn along as fast as possible, this is an absolute must.

DETAILS



PRICE £311.38 (£265 ex VAT)

CONTACT dabs.com 0800 138 5154

www.dabs.com

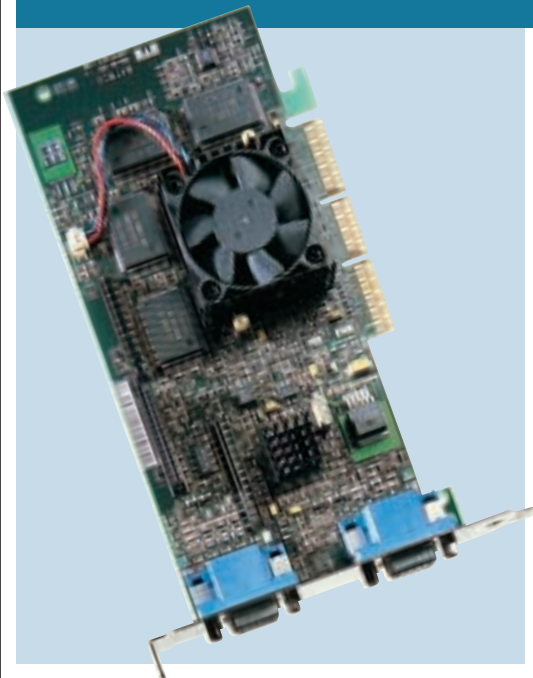
PROS DVI socket; incredible speed from a GeForce2-based card

CONS This is achieved by overclocking the memory and core which may reduce the life of the card

OVERALL Despite the overclocking we found the card to be stable. If it's the fastest card you want, then this is the one. If it's features you need, the Radeon has more



Matrox Millennium G400 Max



WE FIRST REVIEWED the Matrox Millennium G400 well over a year ago and we knew then that Matrox had created something special. The G400 was the first graphics chipset to incorporate hardware environment bump mapping, a DirectX feature

designed to produce more realistic 3D environments. The G400 was also one of the first consumer-based cards to incorporate dual head technology, allowing you to connect to two monitors. Shortly after its release, Matrox improved upon the original G400 by adding a faster processor and RAMDAC, the latter running at 360MHz instead of 300MHz. Aptly named the G400 Max, the extra power of the new card meant that a fan had to be used to cool the heatsink. There's been a lot of activity on the graphics cards front since its original release so how does the Max fare against the current crop of hot chipsets?

In terms of performance, the Max is starting to show its age. At a resolution of 1,280 x 1,024 with 16bit colour, it only scored 2,212 in the 3DMark tests, which places it second from the bottom in the group. In the Quake III tests, it only managed 17.6fps at 1,280 x 1,024 with 16bit colour,

placing it last. The G400 Max did surprise us by achieving 800 3DMarks at 1,600 x 1,200 in 32bit, but gameplay at these settings would be impossible.

The G400 Max is lagging behind the rest of the field in this month's test. That said, it isn't just about raw power. Superb image quality and a second D-SUB allow the Max to retain some of its original appeal. There's also a supplied composite and S-Video out all-in-one cable that plugs into the spare D-SUB port. However, if it's cutting edge 3D performance you're after then look elsewhere or wait for the upcoming G450. However, if playing the latest games isn't your top priority, and you're just after a 2D no-nonsense card then the G400 Max still has a lot going for it.

DETAILS



PRICE £151.57 (£129 ex VAT)

CONTACT dabs.com 0800 138 5154

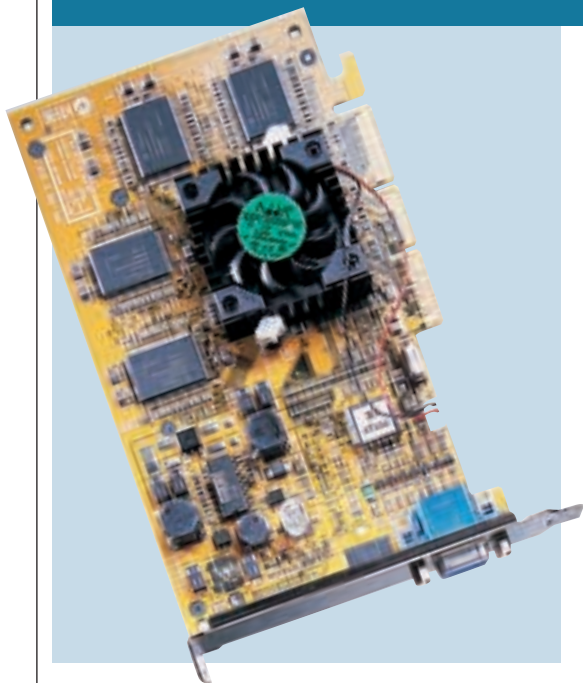
www.dabs.com

PROS An excellent reputation for 2D; second display output

CONS Poor 3D performance; not for serious gamers

OVERALL A good feature set and good 2D, but is out of its league in terms of 3D

MSI MS-StarForce 815



MSI is a Taiwanese company that's best known for its motherboard production. In fact MSI produced the first (and only for a while) AMD Athlon motherboard and was also showcasing the first 1GHz AMD Athlon Thunderbird system on its stand at Computex Taipei a couple of

months ago. Like many Taiwanese motherboard manufacturers, MSI has now expanded into the graphics card market, although this area is getting more cut-throat all the time. Not long ago manufacturers could produce graphics boards based on chipsets from nVidia, 3dfx and S3, but now only nVidia produces chips for other companies. So, the MSI, along with most cards in this test is based on nVidia's GeForce2 GTS chipset.

Backing up the nVidia GeForce2 chip is 32MB of memory, which is more than enough to handle the size of textures in current games. In fact, if games developers ever start using texture compression properly, we

may see the end of the ongoing spiral of increasing video memory. The MSI performed no better or worse than any other 32MB GeForce2 card in the 3DMark tests, but in Quake III and Test Drive 6 it performed slightly better, placing in the upper half in most tests.

Inside the box you'll find installation instructions, a driver CD and a copy of WinDVD in case you want to watch movies on your PC, assuming you have a DVD-ROM drive of course.

There's nothing special about this card, it doesn't have the video in/out feature of the 32MB ELSA Gladiac, and it doesn't even have the expansion connector to fit it as an upgrade. You're getting a no-frills GeForce2 card that performs well enough in 3D applications. Of course, you're not getting hardware environment bump mapping in the feature set, but you are getting those four pipelines that help it outperform the Radeon in 16bit. If you're looking for a good value 32MB GeForce2 graphics adaptor, the ELSA offers a stronger feature set at a great price.

DETAILS



PRICE £245 (£208.51 ex VAT)

CONTACT Microteq Innovations

01733 896 667 www.msi.com.tw

PROS GeForce2 chipset; solid performance

CONS Light on features; better value options available

OVERALL A basic GeForce2 card that's eclipsed a little by the ELSA

Smoothing out the bumps

Anti-aliasing is used to smooth out the pixellation that appears in graphics generation, most notably when a diagonal straight edge is drawn. What it does in simple terms is to remove the step effect that is especially noticeable on straight diagonal lines and curves, by blurring the on-screen pixels, thus removing the pixel corners and smoothing the image. The effect of this can be quite spectacular in removing the 'step' effect, especially in lower resolutions where the pixels are larger and, by definition, the problem is more pronounced.

Until recently, anti-aliasing has been confined to small areas of the scene, thus reducing the processing requirement across the whole scene. Recently, though, cards have started to support full scene anti-aliasing (FSAA) which means the whole image has anti-aliasing applied to it, thus removing pixel edges across the whole screen. This certainly looks good – and you have the time to see the effect on some cards because the frame rate drops so low that it's like watching a slide show.

3dfx has recently drawn a lot of attention to FSAA with the launch of its Voodoo5 5500, which boasts two and four-sample realtime FSAA. And unfortunately it has been slammed in the press for the frame rate hit that accompanies use of the feature. In the interest of fairness (and



Smoother pantie line: Lara without FSAA enabled on the left. FSAA has been turned on for the shot on the right – see the smoother lines where pixels have been blurred

curiosity) we therefore decided to test a few cards to see how all of them coped with FSAA. We tested the Asus V7700 Pure, the ELSA Gladiac 64MB, the Voodoo5 5500 and the new ATi Radeon. All were tested first without FSAA enabled, then with it enabled for direct comparison. For the GeForce2-based cards this involved using nVidia's most up-to-date reference drivers (version 5.32), as previous versions did not have the FSAA element enabled, while with the Voodoo5 we tested first at two-sample FSAA and then at four. The results are extremely interesting.

With 16bit colour and textures enabled in Quake III at 1,280 x 1,024 frame rates ranged from 76.2fps from the Asus V7700 to 51.6fps from the ATi Radeon. The Voodoo5 achieved a respectable 63.4fps, while the 64MB ELSA Gladiac achieved 75fps. All are excellent frame rates for the

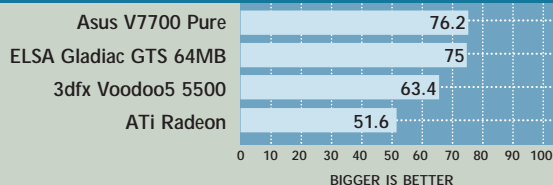
resolution. When FSAA is turned on all the cards suffered a substantial frame rate hit. What is most interesting is how much their original frame count is knocked down while the FSAA feature is enabled. The Asus suffered a massive 60 per cent drop in fps, the Gladiac a 52 per cent drop, while the Radeon suffered a 65 per cent drop. Interestingly, at two-sample FSAA the Voodoo5 did best of all, losing only 47 per cent of its non-FSAA fps, while at four-sample FSAA it was comparable to the Radeon, losing 65 per cent of its non-FSAA fps. So despite the fact that the Voodoo5 had the lowest frames per second after application of FSAA (achieving only 17.8fps), it was not affected as badly as any of the other cards. At 1,280 x 1,024 in 32bit the results were similar. The Asus suffered a 60 per cent reduction to its frames per second, the Gladiac 54 per

cent, the Radeon 67 per cent, and at two-sample FSAA, the Voodoo5 lost 56 per cent, where at four-sample FSAA, it would not run at all. All the frames per second at this resolution and colour depth were between 15.9 and 19.6fps.

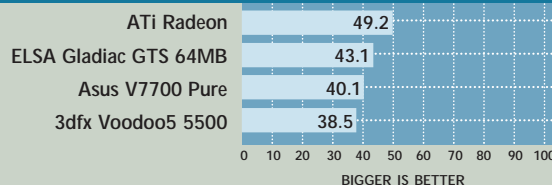
The results are interesting because they actually go some way towards vindicating the Voodoo5, which is in reality not affected by FSAA as greatly as other cards in general terms. As for FSAA generally, it appears it is just too much for today's hardware to process efficiently; and considering its effect on performance, FSAA should probably more accurately stand for 'frame-rate suffers after activation'. That said, if you have a back catalogue of games that don't support today's high resolutions, FSAA could be a real bonus. But ultimately, you have to ask yourself if you really want to play old games anyway.

SCOTT MONTGOMERY

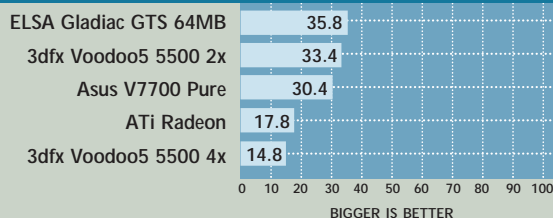
Quake III 1,280 x 1,024 at 16bit (fps)



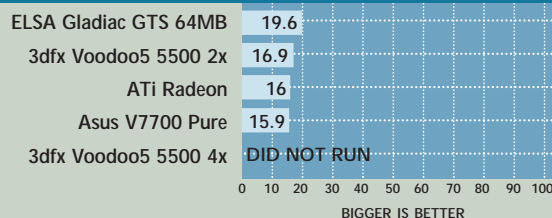
Quake III 1,280 x 1,024 at 32bit (fps)



Quake III with FSAA enabled 1,280 x 1,024 at 16bit (fps)



Quake III with FSAA enabled 1,280 x 1,024 at 32bit (fps)



How we did the tests

The needs of every user are different and this makes it very hard to put together a comprehensive benchmark test. Some people may place more emphasis on 2D performance – with the ability to play a few 3D games a bonus. Others are willing to sacrifice 2D performance to get the best gaming platform possible, at whatever price. Even if this is true, then they may have certain games in mind, which further complicates matters. With all this in mind, we put together the following combination of tests: 3DMark2000, Quake III demo1 and Test Drive 6 Time Demo, running them on one of our PC reference machines, a 733MHz Intel Pentium III plugged into an AGP 4x equipped motherboard with 128MB of RDRAM, all under Windows 98 SE. We decided not to run 2D tests since there is very little difference between these cards in a 2D environment.

3DMark 2000

This is an instruction-set optimised version of 3DMark99 from Futuremark, which tests the 3D capabilities of PCs. It uses a Real World DirectX 7 3D game engine to produce one result in the form of 3DMarks. For standalone reviews and group tests, we usually perform all tests at 1,280 x 1,024 resolution in 16bit colour depth with the test suites set to loop three times. In this test, to push the cards that little bit harder, we also ran the tests at 1,280 x 1,024 in 32bit colour, 1,600 x 1,200 in 16bit colour and 1,600 x 1,200 in 32bit, if those modes were

supported by the card. The higher the score, the better the result.

Quake III

This game gives a good overview of OpenGL performance. Testing cards with Quake III consists of running a recorded game on the test system and getting a final frames per second (fps) score at the end. The higher the score the better, with an fps of 30 or more providing visibly smooth playback.

A couple of demos are already built into the Quake III test – part of the full version game – and we opted for demo 1 which puts a greater demand on the graphics subsystem due to it being



Above: Quake III highlights OpenGL performance
Left: We pushed the cards hard in the 3DMark tests
Below: A racing game put the cards under pressure during the Test Drive 6 demo



Test Drive 6

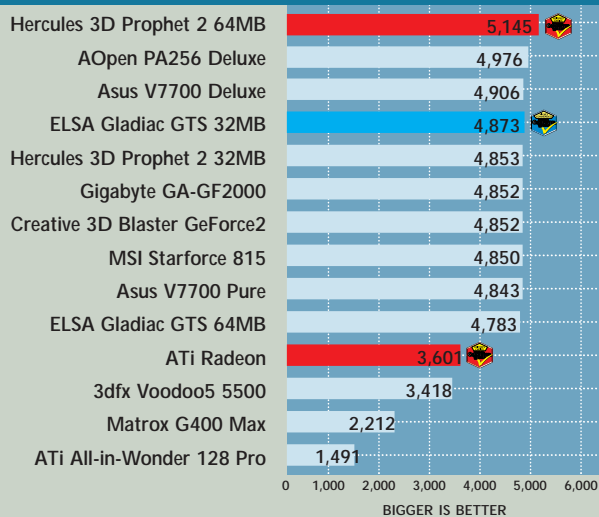
It is hard work putting graphics cards through their paces, involving a lot of repetitive testing and quantitative data collection. Instead of only using the standard first-person shooter game, we further enhanced the quality of our results by including Infogames' Test Drive 6 Time Demo, giving us another fps score. Although first-person perspective games tend to be some of the most popular on the PC, we thought adding a driving game into the mix would cover the interests of more end users. Furthermore, this racing game comes with transform and lighting support, putting many of the graphics cards under more pressure. As with the other tests, we ran the demo four times per card at 1,280 x 1,024 and 1,600 x 1,200 resolutions in both 16bit and 32bit colour.

staged in an open area with no walls. To run the test you need to bring up the console and enter the following commands: `timedemo 1` then press return, followed by `demo demo001`

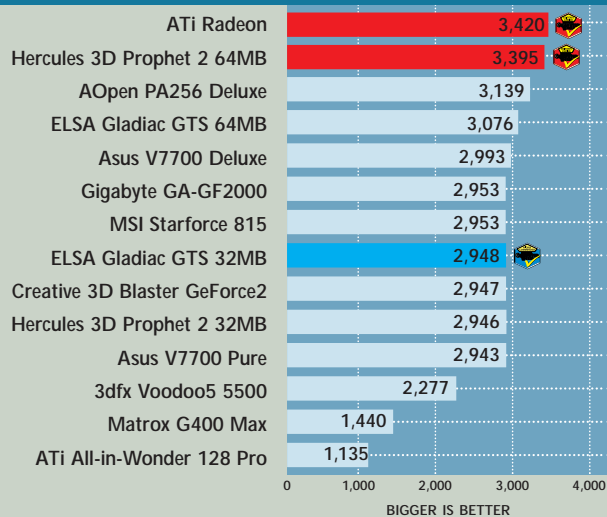
After the demo has finished, bringing up the console again will display the overall fps score. We ran the test four times for each card at 1,280 x 1,024 and 1,600 x 1,200 resolutions in both 16bit and 32bit colour, with the game settings at their maximum.

3DMark 2000

3DMark 2000 1,280 x 1,024 at 16bit

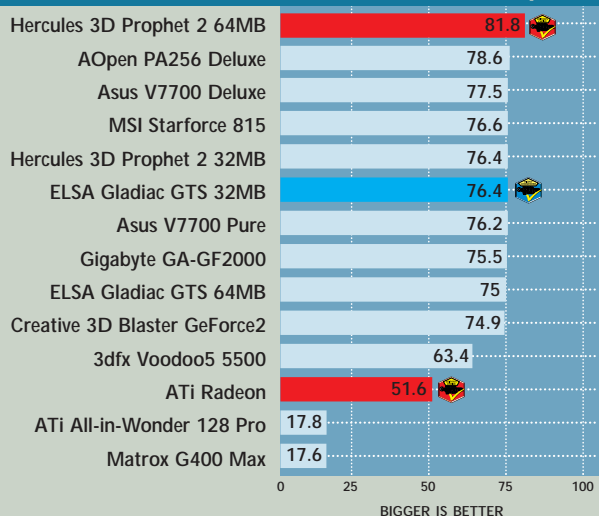


3DMark 2000 1,280 x 1,024 at 32bit

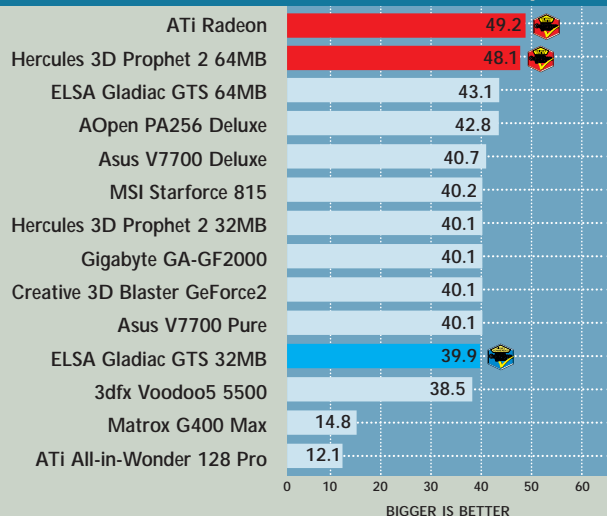


Quake III Demo

Quake III Demo 1,280 x 1,024 at 16bit (fps)

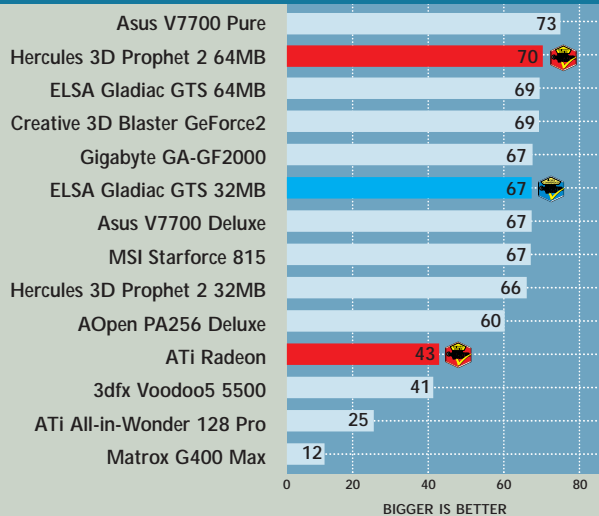


Quake III Demo 1,280 x 1,024 at 32bit (fps)

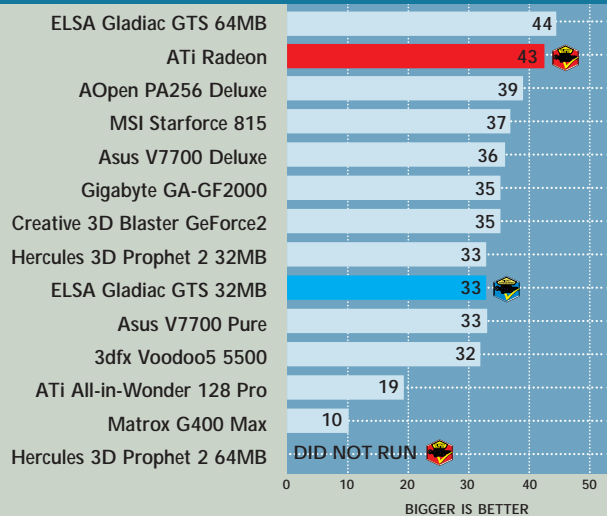


Test Drive 6 Time Demo

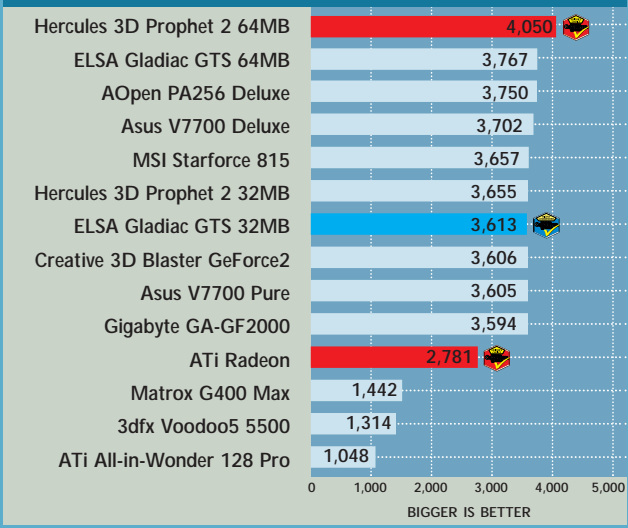
Test Drive 6 1,280 x 1,024 at 16bit (fps)



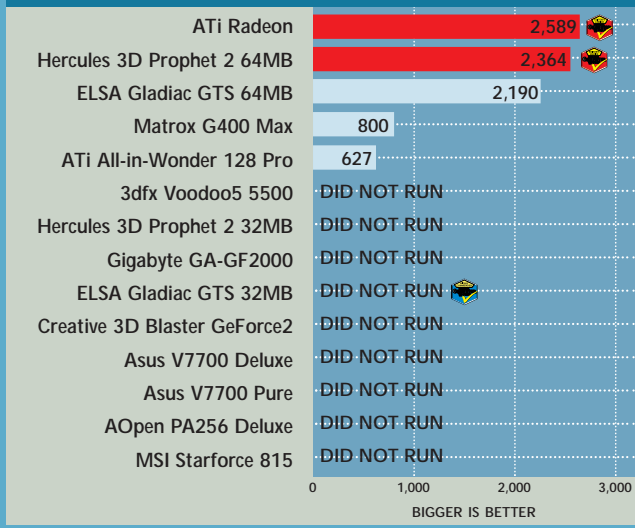
Test Drive 6 1,280 x 1,024 at 32bit (fps)



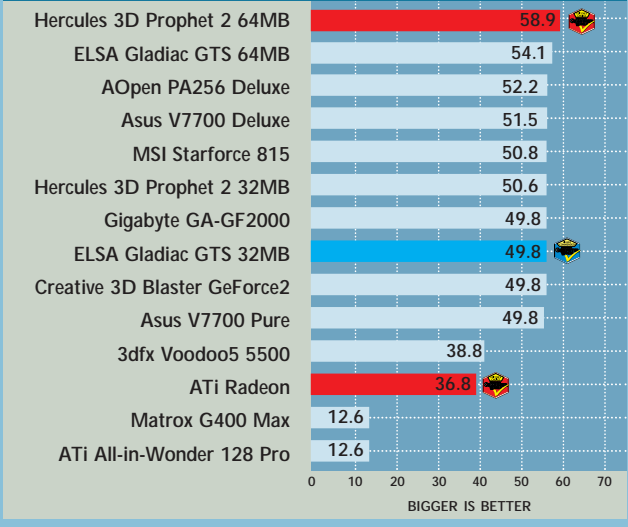
3DMark 2000 1,600 x 1,200 at 16bit



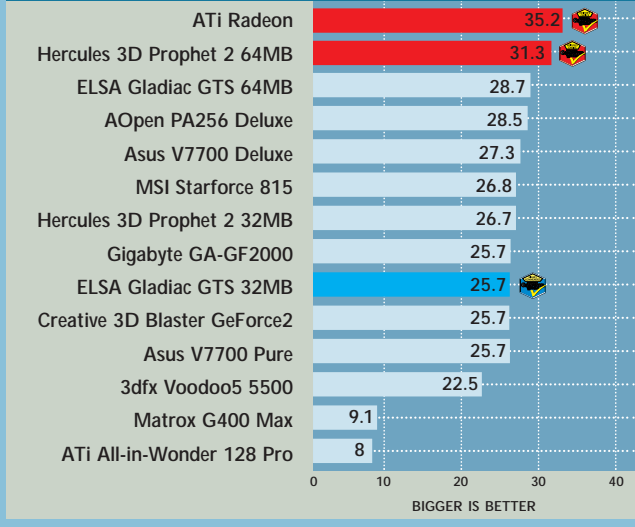
3DMark 2000 1,600 x 1,200 at 32bit



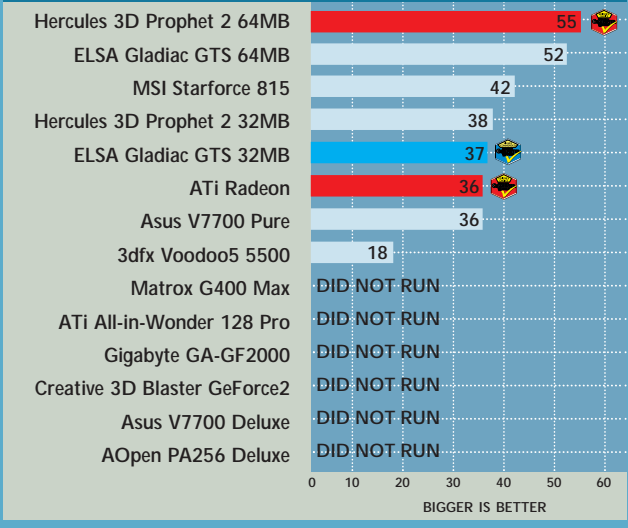
Quake III Demo 1,600 x 1,200 at 16bit (fps)



Quake III Demo 1,600 x 1,200 at 32bit (fps)



Test Drive 6 1,600 x 1,200 at 16bit (fps)



Test Drive 6 1,600 x 1,200 at 32bit (fps)

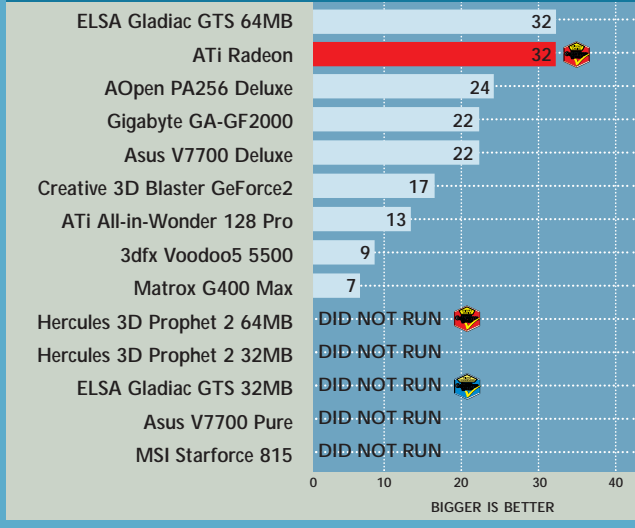
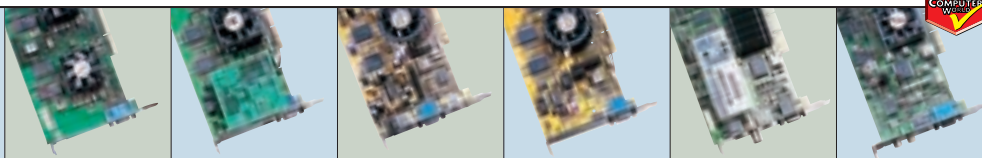












Table of features



MANUFACTURER	3DFX	AOPEN	ASUS	ASUS	ATI	ATI
PRODUCT	VOODOO5 5500 AGP	PA256 DELUXE	V7700 DELUXE	V7700 PURE	ALL-IN-WONDER 128 PRO	RADEON
Price inc VAT (ex VAT)	£210.32 (£179)	£249 (£212)	£285.52 (£243)	£269.07 (£229)	£169.20 (£144)	£299 (£254)
Manufacturer URL	www.3dfx.com	www.aopen.nl	www.asus.com	www.asus.com	www.ati.com	www.ati.com
Supplier name	dabs.com	Majestic Technologies	Ultimate Hardware	dabs.com	dabs.com	dabs.com
ESSENTIALS						
Chipset	Dual VSA-100	nVidia GeForce2 GTS	nVidia GeForce2 GTS	nVidia GeForce2 GTS	ATI Rage 128 Pro	ATI Radeon
GPU core clock speed (MHz)	166	200	200	200	Not supplied	183
RAMDAC frequency (MHz)	350	350	350	350	300	350
Overclocking facility	X	✓	✓	✓	X	X
Interface	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP
Memory/type	64MB/SDRAM	32MB/DDR SGRAM	32MB/DDR SGRAM	32MB/DDR SGRAM	32MB/SDRAM	64MB/DDR SDRAM
Memory frequency (MHz)	166	333 (166 x 2)	333 (166 x 2)	333 (166 x 2)	Not supplied	366 (183 x 2)
Hardware mpeg2 assist	✓	✓	✓	✓	✓	✓
Software DVD player	✓	✓	✓	✓	✓	✓
Composite output	X	X	✓	X	✓	✓
S-Video output	X	✓	✓	X	✓	✓
Other/software	WinDVD 2000	S-Video to RCA video cable, Drakan, Rollcage	3D glasses, S-Video in, games, video-editing software, SmartDoctor	Drakan, Rollcage, Asus SmartDoctor	TV Tuner, S-Video in/ out, stereo audio in/ out, ATI multimedia centre, Ulead Video 4	ATI multimedia centre, cables, S-video in
MAX 2D REFRESH RATES (Hz) AT 16/32BIT COLOUR DEPTH						
1,024 x 768	120/120	200/200	240/200	240/200	200/200	200/200
1,152 x 864	120/120	200/170	200/170	200/170	160/160	150/150
1,280 x 1,024	100/100	170/150	170/170	170/170	130/130	130/130
1,600 x 1,200	100/100	120/100	120/100	120/100	90/90	90/90
3D SUPPORT						
Alpha blending	✓	✓	✓	✓	✓	✓
Anisotropic filtering	X	✓	✓	✓	X	✓
Embossed bump mapping	✓	✓	✓	✓	✓	✓
Hardware environment bump mapping	X	X	X	X	X	✓
Anti-aliasing	✓	✓	✓	✓	✓	✓
Full scene anti-aliasing	✓	✓	✓	✓	X	✓
Bilinear-filtering	✓	✓	✓	✓	✓	✓
Trilinear-filtering	✓	✓	✓	✓	✓	✓
Gouraud shading	✓	✓	✓	✓	✓	✓
Bilinear mip mapping	✓	✓	✓	✓	✓	✓
Fogging	✓	✓	✓	✓	✓	✓
Perspective correction	✓	✓	✓	✓	✓	✓
Transparency (colour & alpha)	✓	✓	✓	✓	✓	✓
Transform and Lighting	X	✓	✓	✓	X	✓
Z buffering bit depth	24bit	32bit	32bit	32bit	32bit	32bit
DRIVERS SUPPLIED						
Windows 95/98	✓	✓	✓	✓	✓	✓
Windows NT4	X	✓	✓	✓	X	✓
Windows 2000	✓	✓	✓	✓	X	✓
Direct3D	✓	✓	✓	✓	✓	✓
OpenGL	✓	✓	✓	✓	✓	✓
Glide	✓	X	X	X	X	X

	 CREATIVE	 ELSA	 ELSA	 GIGABYTE	 HERCULES (GUILLEMOT)	 HERCULES (GUILLEMOT)	 MATROX	 MSI
	3D BLASTER GeFORCE2 GTS	GLADIAC GeFORCE2 GTS 32MB	GLADIAC GeFORCE2 GTS 64MB	GA-GF2000 32MB	3D PROPHET II GTS 32MB	3D PROPHET II GTS 64MB	MILLENNIUM G400 MAX	MS-STARFORCE 815
	£215.02 (€183)	£216.20 (€184)	Not supplied	£239 (€203.40)	£246.74 (€209.99)	£311.38 (€265)	£151.57 (€129)	£245.00 (€208.51)
	www.europe.creative.com	www.elsa.co.uk	www.elsa.co.uk	www.gasteiner.com	www.hercules.com	www.hercules.com	www.matrox.com/mga	www.msi.com.tw
	dabs.com	dabs.com	Not supplied	020 8345 6000	jungle.com	dabs.com	dabs.com	Microteq Innovations
	nVidia GeForce2 GTS	nVidia GeForce2 GTS	nVidia GeForce2 GTS	nVIDIA GeForce2 GTS	nVidia GeForce2 GTS	nVidia GeForce2 GTS	Matrox G400	nVidia GeForce2 GTS
	199	200	200	200	200	220 (overclocked)	Not supplied	200
	350	350	350	350	350	350	360	350
	x	✓	✓	✓	✓	✓	x	✓
	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP	2x/4x AGP
	32MB/DDR SGRAM	32MB/DDR SGRAM	64MB/DDR SGRAM	32MB/DDR SGRAM	32MB/DDR SGRAM	64MB/DDR SGRAM	32MB SGRAM	32MB/DDR SGRAM
	333 (166 x 2)	333 (166 x 2)	333 (166 x 2)	333 (166 x 2)	333 (166 x 2)	365 (183 x 2 overclocked)	Not supplied	333 (166 x 2)
	✓	✓	✓	✓	✓	✓	✓	✓
	x	✓	✓	x	✓	✓	✓	✓
	x	✓	x	x	x	x	✓ (with supplied cable)	x
	x	x	x	x	✓	✓	✓ (with supplied cable)	x
	Rage Rally, Sonnetech Colorific, 3Deep, LAVA! Player	ELSA WINman Suite	ELSA WINman Suite	Not supplied	TV-out, Composite converter, Cyberlink PowerDVD	DVI-out, Cyberlink PowerDVD	Dual D-SUB, Micrografix Picture Publisher, Simply3D, PointCast	WinDVD 2000
	200/200	200/200	200/200	200/200	240/200	240/200	160/160	200/200
	170/170	170/170	170/170	200/170	200/170	200/170	140/140	150/150
	170/150	170/150	170/150	170/150	170/170	170/170	120/120	120/120
	120/100	120/100	120/100	150/120	120/100	120/100	100/100	85/85
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	x	x	x	x	x	x	✓	x
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	x	✓
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	32bit	32bit	32bit	32bit	32bit	32bit	32bit	32bit
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓	✓
	x	x	x	x	x	x	x	x



Editor's Choice

Our last look into the rapidly changing world of graphics cards was a mere 10 months ago (*PCW* December 1999). Less than a year has passed, yet you would hardly even recognise that we were looking at the same component, such is the performance of today's cards. The Editor's Choice last December was Matrox's G400 Max, which appears in this group test as it is still the best 2D card on the market – and because it acts as a marker to highlight how much better current cards perform.

Since the last test 3D performance has literally skyrocketed through two generations of GPUs (the GeForce and now the GeForce2), allowing 3D games to run at incredible resolutions, yet still look spectacular. In the December tests, the Matrox Millennium G400 Max card was topping some of the tables with scores of 51.1fps in Quake III at 1,024 x 768 in 32bit. Back then this was quite a score for this resolution, and for those still running mid-range machines, it is still a more than acceptable frame count.

Today, similar frame rates can be achieved at 1,280 x 1,024 in 32bit, and even at 1,600 x 1,200 in 16bit for most cards, compared to 30fps by the best cards in the last test. The card manufacturers have made a lot of progress since December.

Graphics performance of cards has reached such a level now that not only is the frame count relevant, but also how refined the image is. However, as the section on full-scene anti-aliasing highlights, some visual refinement can

come at too great a cost. Still, ATI has managed to get hardware environment bump mapping onto its Radeon chip (the first card to do so since the Matrox G400) and it looks absolutely spectacular. Crowded round a monitor in the lab when we first got this card in, we ran some demos of bump mapping, and what we saw was breathtaking.

Unfortunately, nVidia has still opted not to include environment bump mapping on the second-generation GeForce2 GPU, although this is probably a space constraint due to the four pipelines. With graphics cards though, one still has to respect raw polygon-shifting power. The ability to drive the graphics to such a level that ultra-smooth jerk-free gaming occurs no matter what is on the screen, certainly demands admiration and that is where the GeForce2 cards are excellent.

The winners

The top runners were grouped tightly together in terms of performance. Thankfully it wasn't the one-horse race we feared, and ATI cut it fine to get its new Radeon into us in time for testing. But we got the card and, as king of 32bit rendering, the ATI Radeon is our first **Editor's Choice**. This was based on many things, although most notably on the multitude of features the card boasts. Not only does it have hardware environment bump mapping as well as a powerful Transform and Lighting engine, but it also sports video in and out, making it an ideal card for the home video enthusiast. The Radeon, like all ATI

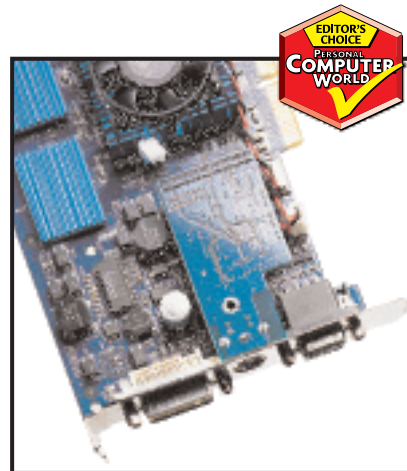
cards, also has great motion compensation, which gives the highest quality DVD playback from a card not solely dedicated to MPEG2 decoding.

Features are one thing in the arena of graphics cards, raw power is quite another. On the basis of this, it seemed only fair to award a second **Editor's Choice** award based on raw power alone. The winner is the 3D Prophet II 64MB from Hercules, which was far and away the fastest (and hottest) card in the tests. Overclocked by 10 per cent in both its core and memory, the heatsinks strapped onto the card are both practical and attractive. With S-Video (and a composite convertor) and a DVI socket as standard, it also has some connectivity variation that other cards do not. Only one thing concerned us, and that was the longevity of an overclocked card. But then if Hercules thinks it'll be all right, it probably will.

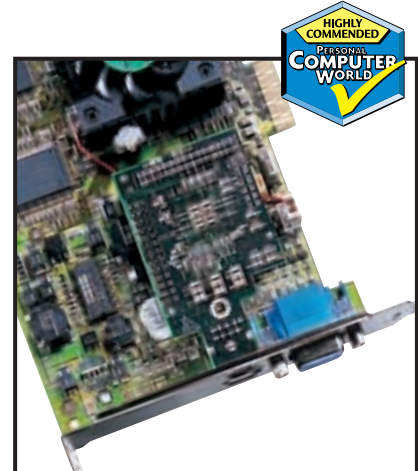
The final award winner was chosen on value for money. For the gamer, all that is important is getting the fastest, cheapest option. Fitting best into this category is the ELSA Gladiac GTS 32MB, the winner of this month's **Highly Commended** award. Considering most of the 32MB GeForce2 cards run at much the same speed, the cheapest of them will give you almost the same performance as the best. Common sense therefore dictates plumping for one of the cheapest cards on test. As well as a reasonable price, the ELSA also includes video in and out, which will come as a welcome addition for the video enthusiast, too.



The great features of ATI's Radeon make it ideal for home-video enthusiasts



Hercules' 3D Prophet II 64MB was the hottest card in the test – literally



ELSA's Gladiac GTS 32MB has a reasonable price and some good features