Graphics cards

If you want to boost your PC's 3D performance, look no further than this massive group test

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When it comes to sheer 3D power, there are currently only two major graphics card players around: Nvidia and ATi. And 3D is what this Labs is all about, whether it's frame rates for today's games or features for next year's technology-stretching crop.

As ever, we're amazed at the rate of progress in the graphics arena. It seems only a short time ago that Nvidia unleashed the nv20 upon the gaming world. Better known as the GeForce3 family, it pioneered exciting new features such as programmable Pixel and Vertex Shaders to the mainstream along with plenty of grunt to deliver high frame rates.

ATi's answer to the nv20 was the Radeon 8500 – still a current and feature-packed GPU. It leapfrogged the GeForce3's DirectX 8 support with its DirectX 8.1-compliant Pixel Shader. Another big innovation by ATi is that it has finally decided to license its GPUs, and Hercules – one of the strongest graphics brands around – has ditched Nvidia for ATi.

But now Nvidia has its GeForce4 family. Catering for the budget market is the GeForce4 MX, which is based on GeForce2 MX technology yet includes a host of extra features and performance – at least for the 440 and 460 iterations – rivalling the old GeForce2 Ultra. The other half of the GeForce4 clan is the Ti range, where you can choose between the 4200, 4400 and 4600. To see how they all performed, go to Performance analysis on p78.

All these GPUs combined mean that there's a card here that will almost certainly boost your PC's 3D performance, whether you have £80 or £300 to spend. And it's not just about faster frame rates – many of these cards offer excellent anti-aliasing, which will bring a new lease of life to your existing games collection.
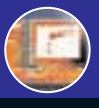
How we test

We always strive to keep our benchmarks as real world as possible, and for this new generation of graphics cards, we've assembled a suite of tests designed to stretch them to their limits.

THE TEST RIG

For the new system, we use a 2GHz Pentium 4 with 256Mb of PC2100 DDR SDRAM from evesham.com. This is fitted with a Gigabyte 8IRM motherboard and a Western Digital Caviar WD400BB hard disk. It's a powerful platform that will get the most out of current cards and allow the fastest cards to flourish. We then install Windows XP Home, which we see as the likely choice of gaming platform and, where possible, use WHQL (Windows Hardware Quality Labs) drivers.

THE TESTS

Instead of quoting a combination of frame rates and 3DMark scores as we've done in the past, we now quote a *PC Pro* 3D score, which allows quick comparisons between cards. We've upped the test resolution from 1,024 x 768 to 1,280 x 1,024 in 32-bit colour and include a second test using 4x FSAA (Full Scene Anti-Aliasing) in XGA for a substantial challenge.

The results for each benchmark are recorded, before being weighted and combined to provide an index against our reference Nvidia GeForce2 Ultra graphics card, which gives a score of 1.

Evolva stretches cards to the limit with Dot3 bump mapping.

EVOLVA

Evolva is a DirectX 7-based Direct3D game that takes advantage of hardware Transform & Lighting. The game engine supports Dot3 bump mapping, which puts more stress on the graphics card. We use the automated cycle in the Evolva bump-mapped rolling demo, which delivers frame-rate timing information at the end. The demo defaults to XGA, but you can change this by running the Registry Editor and going to HKEY_LOCAL_ MACHINE\SOFTWARE\ ComputerArtworks\ EvolvaRollingDemo\1.0.

SERIOUS SAM

With cards now regularly hitting high three-figure frame rates in Quake III, we've upped the ante slightly. We chose Serious Sam: The

Serious Sam gives a serious test of OpenGL performance.

First Encounter as our new OpenGL test. We use the Serious Sam MP0002 demo – a real test of raw power, thanks to its wide open spaces that keep the polygon count sky high. We set the graphics to Quality settings in 32-bit colour with sound disabled. To run the test, enter the console and type dem_bprofile=1, then run mpdemo_0002 from the Demo menu.

AQUAMARK

This is a DirectX 8-based benchmark utility derived from the game AquaNox, and supports Pixel and Vertex Shaders. The test also runs on cards that don't support these features, but they're penalised in

AquaMark takes advantage of the latest DirectX 8 features.

our calculations as a result. AquaMark is one of the toughest benchmarks in the suite, and most of the cards struggle to deliver playable frame rates in the 4x anti-aliasing test.

3DMARK2001 SECOND EDITION

3DMark2001SE is a synthetic benchmark utility. It uses a mix of DirectX 7 and DirectX 8 Direct3D tests and gives an overall 3DMark score based on the combined results of each test. The final test, Nature, will only run on cards with Pixel and Vertex Shaders. As such, these cards score more highly overall.
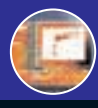
As this is a synthetic benchmark, it has a slightly lower weighting in the overall 3D score. We run the test with triple buffering and 32-bit textures as the only changes from the standard settings.

The Nature test only runs on cards with programmable Pixel and Vertex Shaders.

Performance analysis

We examine the differences between each GPU featured in this Labs and what impact they have on performance

Although there are 21 cards in this Labs, only three companies manufacture the chipsets they use. Between Nvidia, ATi and PowerVR, there are six main chipsets, but variations in clock speeds and technology mean there are 14 choices. In Nvidia's catalogue are the GeForce4 Ti and MX ranges, ATi has the Radeon 8500, 7500 and 7000, while PowerVR's current offering is the ageing Kyro II. All cards have 64Mb of memory on board except the GeForce4 Ti cards, which boast 128Mb.

The graphs below show the performance of the 14 chipsets in each test and also an overall ranking. The precise results for each card are at the foot of the feature table (*see p76*).

BUDGET BUYS

At the bottom sits the Radeon 7000E, which scored 0.19 overall, well behind the next slowest GPU. The 7000E was previously called the Radeon VE, a cut-down version of the original Radeon R100 chip. This goes some way to explaining its poor performance compared with today's chipsets.

In terms of features, the 7000E is more than capable enough to play DVD movies, but is only DirectX 7 compliant. Its single rendering pipeline is a big hindrance to performance, but another contributor is the SDR memory running at just 155MHz. Also, like the Kyro II, the 7000E has no hardware Transform & Lighting engine.

Next up the performance scale is the GeForce4 MX 420, sliding in just below the Kyro II. GeForce4 MX chipsets are essentially better-featured GeForce2 cards. Unlike the GeForce2, however, the GeForce4 MX boasts a variant of the Ti's Lightspeed Memory Architecture II, with only half the crossbar memory controllers. This aids performance, but its strengths lie in the features it shares with the Ti, such as multisampling anti-aliasing and full nView Extended Desktop support. The MX also has a VPE (video processing engine) to reduce CPU overhead for tasks like DVD playback.

Unlike other MX cards on test, the MX 420 is paired with SDR memory, which, not surprisingly, hampered its progress in our benchmarks. Standard memory clock speed is 166MHz, equating to a lowly 2.7Gbits/sec of bandwidth. Core clock is 250MHz, 20MHz behind the MX 440. Aside from these variances, the MX 420 has the same features as the MX 440 and MX 460.

With an overall score of 0.60, the MX 420 is considerably slower than a GeForce2 Ultra and only gave playable frame rates in Evolva and Serious Sam. Forget about using anti-aliasing – the highest frame rate we saw in the FSAA tests was 14.2fps in Serious Sam. The MX 420 may be a budget buy, but the SDR memory is its Achilles heel.

The PowerVR Kyro II improves on the MX 420's memory speeds slightly, but gives away 75MHz on core clock speed at only 175MHz. The Kyro II is unique in this Labs in that it uses tile-based rendering, which gives it the opportunity to only render the objects that will be seen in a frame, saving memory bandwidth.

But the Kyro II isn't new technology, and faster cards such as the GeForce4 Ti and Radeon 8500 use alternative Z-occlusion culling techniques to save bandwidth. This, combined with the competition's faster speeds, makes the Kyro II less enticing.

MID-RANGE CARDS

ATi's Radeon 7500LE is simply a slower version of the 7500, but both are similar performers. It's worth noting that Hercules' 3D Prophet All-in-Wonder 7500 has lower core and memory clocks than ATi's original specifications, so the 7500 is ranked lower than it otherwise would be.
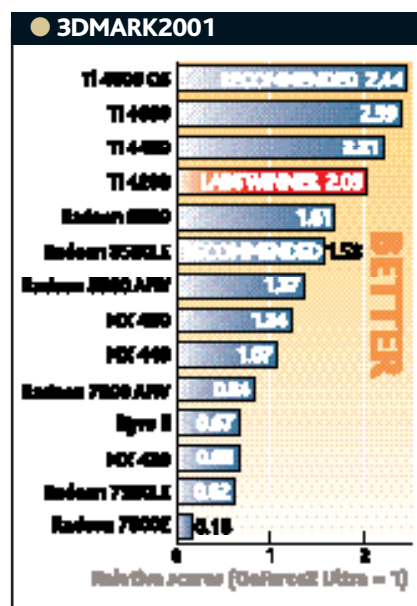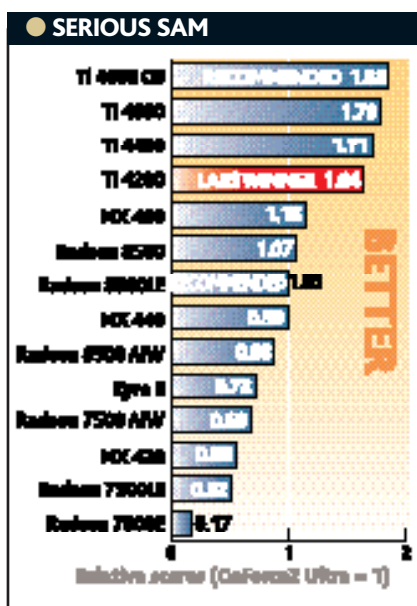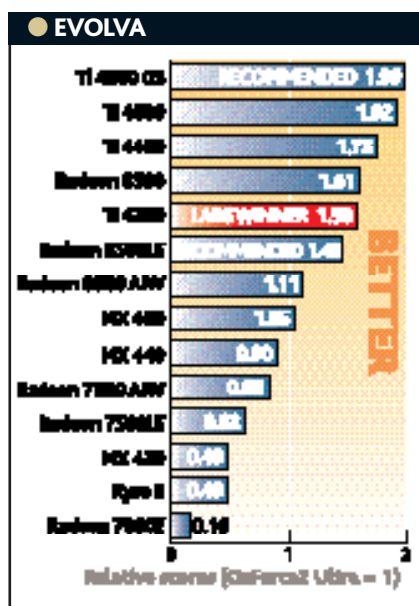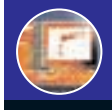
The underlying technology of the 7500 (RV200 chip) is essentially the same as the Radeon R100, with the memory interface of the 8500 (R200), support for HydraVision and a die fabbed at 0.15 micron.

Ultimately, the 7500 and 7500LE aren't great performers. At SXGA, both produced acceptable frame rates in Evolva and Serious Sam, but AquaMark brought them to their knees, with both managing less than 15fps.

Nvidia's GeForce4 MX 440 and MX 460 are next, hovering around the performance of our baseline GeForce2 Ultra with overall scores of 0.97 and 1.13 respectively. We tested an Nvidia reference MX 460 card – retail cards should be available soon. The MX 440 has a core clock of 270MHz and memory running at 400MHz, while the MX 460 runs at 300MHz with memory at 550MHz.

Both GPUs gave decent frame rates in Evolva and Serious Sam, but couldn't manage 25fps in AquaMark. If you want an inexpensive graphics card to run today's games with ease, the MX 440 or MX 460 are great choices, but their lack of DirectX 8 features and general performance means they'll struggle with the next generation of games.

HIGH-PERFORMANCE MACHINES
The Radeon 8500 – in its various guises – marks the first step up in the next generation of DirectX 8 cards. Again, Hercules' All-in-Wonder 8500DV uses lower core and memory clocks than the stock specification, so we chose to separate it. The All-in-Wonder 8500DV was much slower at 1.39 – the 8500LE came in with 1.85 and the 8500 scored 1.99 overall. In simple performance terms, the 8500 is a great GPU at its standard clock speeds and even gives the GeForce4 Ti 4200 a run for its money.

Performance is only half the story, though, since the 8500's features also appeal. The GPU fully supports DirectX 8.1, which means that its Pixel Shader can create more complex effects than a DirectX 8 shader. The 8500's four rendering pipelines can process two textures per clock cycle and six textures in a single pass.

The 8500 also boasts top-quality DVD playback and HydraVision for fully featured dual-monitor support. SmoothVision is another of the 8500's buzzwords, referring to its FSAA capabilities (*see Anti-aliasing explained, p86*), which goes up against Nvidia's Accuview. Truform is another important feature, which is unique in this test. It allows the 8500 to generate curved surfaces without the need to store and render extra triangles, giving high-quality results without sacrificing performance.

While the Radeon 8500 is very capable on today's games – and should be on the next generation – Nvidia has fought back with the GeForce4 Ti, which tops our performance charts. It features support for AGP 8x and up to 128Mb of memory to increase performance at higher resolutions. The Ti 4200 is the lowest spec GPU, with 64Mb of DDR SDRAM at 500MHz and a core clock of 250MHz. The Ti 4400 ups these to 275MHz and 550MHz respectively, while the flagship Ti 4600 runs at 300MHz and 650MHz. Gainward's Ti 4600 Golden Sample is capable of speeds of 310MHz and 680MHz.

As memory bandwidth continues to be a big bottleneck in performance, Nvidia builds on the original Lightspeed Architecture of the GeForce3, and the second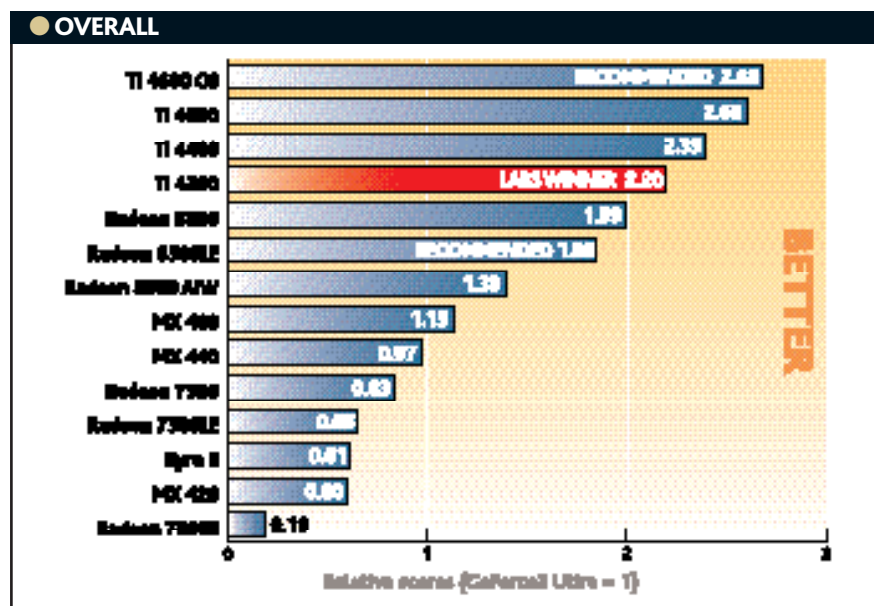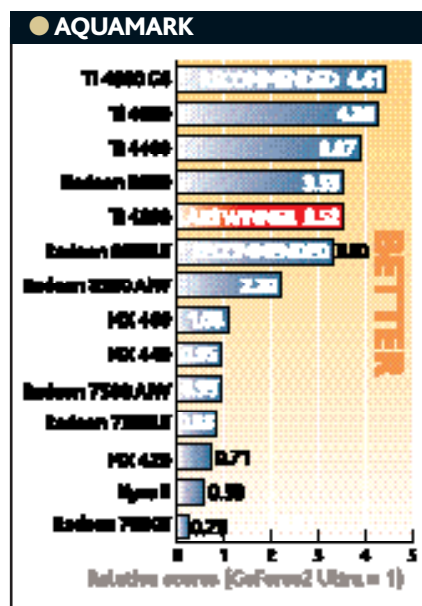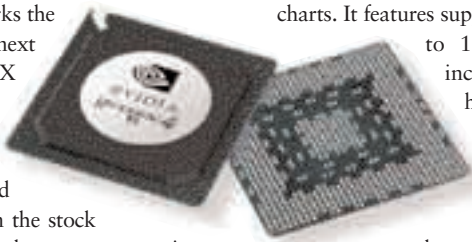 generation uses available bandwidth even more efficiently. Another significant change is nfiniteFX II, which introduces two parallel Vertex Shaders. This means that as game complexity increases, the Ti should still cope.
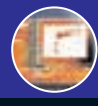
Accuview is the Ti's new anti-aliasing system and, given the GPU's excellent performance, you can actually use the technology now without losing smooth frame rates. Interestingly, the Ti also features nView, allowing dual monitor support – something traditionally lacking in game-oriented cards. We initially considered the lack of the GeForce4 MX's VPE a little odd, but the Ti is likely to be installed into powerful systems that can easily cope with the extra work.

Performance-wise, the Ti 4600 was the only chipset to give playable frame rates in all our benchmarks, but the Ti 4400 was right behind, only struggling with the 4x anti-aliased AquaMark test. The Ti 4200 was faster than the Radeon 8500 overall, but the 8500 had the edge in certain benchmarks.

THE FINAL WORD
If you're serious about gaming, you shouldn't be just looking for performance though. Features are arguably as important, since they determine which advanced 3D effects can be produced – some are required to run the latest games. If you want to future-proof your investment, it's well worth buying a card that has full DirectX 8 or 8.1 support. There may not be a great deal of DirectX 8 games currently available, but many are on the horizon, and when they come out you'll

AQUAMARK

Ti 4600 GS	RECOMMENDED 4.61
Ti 4600	4.36
Ti 4400	8.67
Radeon 8500	3.53
Ti 4200	LABS WINNER 3.52
Radeon 8500LE	RECOMMENDED 3.60
Radeon 8500 AIW	2.30
MX 460	1.04
MX 440	0.65
Radeon 7500 AIW	0.5
Radeon 7500LE	0.73
MX 420	0.71
Xyra II	0.50
Radeon 7500	0.29

Relative scores (GeForce2 Ultra = 1)

OVERALL

|	
Ti 4600 GS	RECOMMENDED 2.61
Ti 4600	2.50
Ti 4400	2.39
Ti 4200	LABS WINNER 2.00
Radeon 8500	1.99
Radeon 8500LE	RECOMMENDED 1.85
Radeon 8500 AIW	1.39
MX 460	1.13
MX 440	0.97
Radeon 7500	0.83
Radeon 7500LE	0.65
Xyra II	0.61
MX 420	0.60
Radeon 7500	0.10

Relative scores (GeForce4 Ultra = 1)
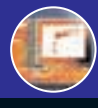
● SPECIFICATIONS AND FEATURES

	Abit Siluro GF4 Ti 4400	Asus V8440	Asus V8460 Ultra	Creative 3DBlaster 4 Titanium 4400	Gainward GeForce4 PowerPack! Ultra/650 TV/DVI	Gainward GeForce4 PowerPack! Ultra/750 XP Golden Sample	Gigabyte Maya AP Radeon 8500 Deluxe	Gigabyte Maya AP Radeon 8500 Pro	Gigabyte Maya AR Radeon 7500 Pro	Gigabyte Maya AV Radeon 7000 Pro
Overall score	116	116	114	113	127	123	115	122	85	61
Street price* (inc VAT)	£232 (£273)	£235 (£276)	£311 (£365)	£213 (£250)	£139 (£163)	£300 (£353)	£188 (£221)	£137 (£161)	£71 (£83)	£46 (£54)
Postage/small order charge (inc VAT)	✘	£6 (£7)	£6 (£7)	£8 (£9)	✘	✘	✘	✘	£2.75 (£3.23)	£2.75 (£3.23)
Supplier	dabs.com 0800 138 5182	Micro Direct 0870 444 4456	Micro Direct 0870 444 4456	Jungle.com 08000 355 3555	Simply 0870 727 2100	Simply 0870 727 2100	dabs.com 0800 138 5182	dabs.com 0800 138 5182	dabs.com 0800 138 5182	dabs.com 0800 138 5182
Supplier's Web site	www.dabs.com	www.microdirect. co.uk	www.microdirect. co.uk	www.jungle.com	www.simply.co.uk	www.simply.co.uk	www.dabs.com	www.dabs.com	www.dabs.com	www.dabs.com
Manufacturer's Web site	www.abit.com.tw	www.asus.com.tw	www.asus.com.tw	www.uk.europe. creative.com	www.gainward.de	www.gainward.de	www.gigabyte. com.tw	www.gigabyte. com.tw	www.gigabyte. com.tw	www.gigabyte. com.tw
Warranty	2yrs RTB	3yrs RTB	3yrs RTB	2yrs RTB	3yrs RTB	3yrs RTB	2yrs RTB	2yrs RTB	2yrs RTB	2yrs RTB
SPECIFICATION										
GPU (inc version number)	Nvidia GeForce4 Ti 4400	Nvidia GeForce4 Ti 4400	Nvidia GeForce4 Ti 4600	Nvidia GeForce4 Ti 4400	Nvidia GeForce4 Ti 4200	Nvidia GeForce4 Ti 4600	ATi Radeon 8500	ATi Radeon 8500LE	ATi Radeon 7500LE	ATi Radeon 7000E
RAMDAC frequency (MHz)	350	350	350	350	350	350	400	400	350	300
Core clock frequency (MHz)	275	275	300	275	250	310	275	250	230	155
Memory on board (Mb)	128	128	128	128	64	128	64	64	64	64
Memory type	DDR	DDR	DDR	DDR	DDR	DDR	DDR	DDR	SDR	SDR
Effective memory speed (MHz)	550	550	650	550	500	680	550	500	170	155
Memory bandwidth (Gbits/sec)	8.8	8.8	10.4	8.8	8	10.9	8.8	8	2.7	2.5
Maximum resolution at vertical refresh rate (Hz)**	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 85	2,048 x 1,536 @ 85	2,048 x 1,536 @ 75	2,048 x 1,536 @ 60
VIDEO FEATURES										
Motion compensation	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
iDCT hardware acceleration	✘	✘	✘	✘	✘	✘	✔	✔	✔	✔
Deinterlacing	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Temporal	Temporal	Per pixel adaptive	Per pixel adaptive
Alpha subpicture blending	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Extended Desktop support	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
HDTV	up to 1080i	up to 1080i	up to 1080i	up to 1080i	up to 1080i	up to 1080i	✘	✘	✘	✘
No. of CRTCs	2	2	2	2	2	2	2	2	2	2
ADVANCED 3D FEATURE SUPPORT										
DirectX version optimisation	8	8	8	8	8	8	8.1	8.1	7	7
Dot3 bump mapping	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Environment-mapped bump mapping	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Hardware Transform & Lighting	✔	✔	✔	✔	✔	✔	Charisma II	Charisma II	Charisma	✘
Higher Order Surface Rendering	✘	✘	✘	✘	✘	✘	Truform	Truform	✘	✘
Programmable Vertex Shader	2, nfiniteFX II	2, nfiniteFX II	2, nfiniteFX II	2, nfiniteFX II	2, nfiniteFX II	2, nfiniteFX II	2, SmartShader	2, SmartShader	✘	✘
Programmable Pixel Shader	nfiniteFX II	nfiniteFX II	nfiniteFX II	nfiniteFX II	nfiniteFX II	nfiniteFX II	SmartShader	SmartShader	✘	✘
Full-scene anti-aliasing	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, 3x, 4x, 5x, 6x	2x, 3x, 4x, 5x, 6x	2x, 4x	2x, 4x
Anisotropic filtering	4 TAP	4 TAP	4 TAP	4 TAP	4 TAP	4 TAP	16 TAP	16 TAP	16 TAP	16 TAP
Tile-based rendering	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
No. of textures per cycle	4	4	4	4	4	4	2	2	3	3
No. of rendering pipelines	4	4	4	4	4	4	4	4	2	1
Z-buffer bit depth precision	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit
THEORETICAL PERFORMANCE										
Pixel fill rates (Mpixels/sec)	1,100	1,100	1,200	1,100	1,000	1,200	1,100	1,000	500	166
Texel fill rate (Mtexels/sec)	2,200	2,200	2,400	2,200	2,000	2,400	2,200	2,000	1,500	498
Triangles (Vertices) per second (millions)*	125	125	136	125	114	136	83	78	39	26
BACKPLATE CONNECTORS										
S-Video in/out	Out	Out	Out	Out	Out	In/out via splitter	Out	Out	Out	Out
Composite in/out	Out via splitter	Out via splitter	Out via splitter	Out via splitter	Out via splitter	In/out via splitter	Out via splitter	Out via splitter	Out via splitter	Out
DVI	✔	✔	✔	✔	✔	2	✔	✔	✔	✘
Other	2nd D-SUB via adaptor	2nd D-SUB via adaptor	2nd D-SUB via adaptor	✘	2nd D-SUB via adaptor	2 D-SUBs via adaptors	2nd D-SUB via adaptor	2nd D-SUB via adaptor	✘	✘
DRIVERS AND ACCESSORIES										
Windows 98	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Windows ME	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Windows XP	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Windows 2000 Professional	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Windows NT 4	✔	✔	✔	✔	✔	✘	✔	✔	✔	✘
Software DVD Player	SiluroDVD	Asus DVD2000	Asus DVD2000	✘	InterVideo WinDVD 3.1	InterVideo WinDVD 3.1	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4
Bundled software	Abit Graphic Max, E-Color 3Deep, True Internet Color	AquaNox, Midnight GT, Tweak Ultility 3.51, Video Security 2	AquaNox, Midnight GT, Tweak Ultility 3.51, Video Security 2	Incoming Forces, eRacer (4 track edition)	ExperTool	Serious Sam, ExperTool, E-Color 3Deep, InterVideo WinProducer, InterVideo WinCoder 1.8	Serious Sam, Motocross Mania, Heavy Metal FAKK2, Rune, Oni lite, 4x4 Evolution lite, Gigabyte V-Tuner	Serious Sam, Motocross Mania, Heavy Metal FAKK2, Rune, Oni lite, 4x4 Evolution lite, Gigabyte V-Tuner	Serious Sam, Motocross Mania, Heavy Metal FAKK2, Rune, Oni lite, 4x4 Evolution lite, Gigabyte V-Tuner	Serious Sam, Oni lite, 4x4 Evolution lite, Gigabyte V-Tuner
Bundled accessories	Composite/S-Video splitter, DVI/D-SUB adaptor, composite cable, S-Video cable	Composite/S-Video splitter, DVI/D-SUB adaptor	Composite/S-Video splitter, DVI/D-SUB adaptor	Composite/S-Video splitter	Composite/S-Video splitter, DVI/D-SUB adaptor	Three-port FireWire card, 2 DVI/VGA adaptors, 3D glasses, composite/S-Video in/out splitter	DVI/VGA adaptor, long S-Video/ composite splitter	DVI/VGA adaptor, long S-Video/ composite splitter	Long S-Video/ composite splitter	S-Video cable
TESTED 3D PERFORMANCE										
Evolva: SXGA (fps)	78.6	78.2	84	78	71.3	87.3	76.3	68.8	32.4	7.5
Evolva: XGA, 4xAA (fps)	41.4	41.3	46.5	41.3	36.6	48.4	33.6	30.5	9.7	3.3
Serious Sam: SXGA (fps)	74.1	73.7	76.7	74.2	70.2	77.9	52.1	48.4	30.1	9.2
Serious Sam: XGA, 4xAA (fps)	65.8	60.3	65.3	65.6	61.2	70.9	33.2	30.4	10.3	4.2
3DMark2001: SXGA (3DMarks)	7,585	7,555	7,945	6,999	7,083	8,055	6,432	6,007	2,575	703
3DMark2001: XGA, 4xAA (3DMarks)	4,942	4,941	5,465	4,975	4,241	5,640	2,926	2,702	809	300
AquaMark: XGA (fps)	38.7	38.7	42.3	38.9	35.2	44.1	37.5	35.2	13.8	3.2
AquaMark: XGA, 4xAA (fps)	24	24.3	26.8	23.8	21.9	27.5	20.7	18.9	5.5	1.9

*All prices were correct at time of going to press. **Manufacturer's quoted maximum.
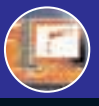
	Hercules 3D Prophet 4500	Hercules 3D Prophet All-in-Wonder 7500	Hercules 3D Prophet All-in-Wonder 8500 DV	Hercules 3D Prophet FDX 8500 LE	Leadtek WinFast A250 TD	Leadtek WinFast A250 Ultra TD	MSI G4MX440-T	Sparkle MX SP7100M4 GeForce4 MX 440	VisionTek Xtacy GeForce4 MX 420	VisionTek Xtacy GeForce4 MX 440	VisionTek Xtacy GeForce4 Ti 4600
	51	83	102	118	119	117	90	80	61	74	112
	£94 (£110)	£149 (£175)	£281 (£330)	£128 (£150)	£230 (£270)	£300 (£353)	£86 (£102)	£90 (£106)	£85 (£100)	£98 (£115)	£306 (£360)
	£3.49 (£4.10)	£5 (£6)	£8 (£9)	£5 (£6)	✘	✘	£10 (£12)	£10 (£12)	£8 (£9)	£8 (£9)	£8 (£9)
	Jungle.com 08000 355 3555	Jungle.com 08000 355 3555	Jungle.com 08000 355 3555	Jungle.com 08000 355 3555	dabs.com 0800 138 5182	dabs.com 0800 138 5182	Micro Direct 0870 444 4456	Micro Direct 0870 444 4456	Data Pro 0161 483 9994	Data Pro 0161 483 9994	Amazon International 0141 776 3399
	www.jungle.com	www.jungle.com	www.jungle.com	www.jungle.com	www.dabs.com	www.dabs.com	www.microdirect.co.uk	www.microdirect.co.uk	www.data-pro.co.uk	www.data-pro.co.uk	www.amazon international.com
	www.hercules-uk.com	www.hercules-uk.com	www.hercules-uk.com	www.hercules-uk.com	www.leadtek.co.uk	www.leadtek.co.uk	www.msi.com.tw	www.sparkle-technology.co.uk	www.visiontek.com/uk	www.visiontek.com/uk	www.visiontek.com/uk
	3yrs RTB	3yrs RTB	3yrs RTB	3yrs RTB	2yrs RTB	2yrs RTB	1yr RTB	1yr RTB	6yrs RTB	6yrs RTB	6yrs RTB
	PowerVR Kyro II	ATi Radeon 7500	ATi Radeon 8500	ATi Radeon 8500LE	Nvidia GeForce4 Ti 4400	Nvidia GeForce4 Ti 4600	Nvidia GeForce4 MX 440	Nvidia GeForce4 MX 440	Nvidia GeForce4 MX 420	Nvidia GeForce4 MX 440	Nvidia GeForce4 Ti 4600
	300	350	400	400	350	350	350	350	350	350	350
	175	258	230	250	275	300	270	270	250	270	300
	64	64	64	64	128	128	64	64	64	64	128
	SDR	DDR	DDR	DDR	DDR	DDR	DDR	DDR	SDR	DDR	DDR
	175	360	380	500	550	650	400	400	166	400	650
	2.8	5.9	6.1	8	8.8	10.4	6.4	6.4	2.7	6.4	10.4
	1,920 x 1,440 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 85	2,048 x 1,536 @ 85	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 60	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75	2,048 x 1,536 @ 75
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘
	Per pixel adaptive Software based	Per pixel adaptive	Temporal	Temporal	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive	Motion adaptive
	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✘	✘	✘	✘	up to 1080i	up to 1080i	up to 1080i	up to 1080i	up to 1080i	up to 1080i	up to 1080i
	1	2	2	2	2	2	2	2	2	2	2
	7	7	8.1	8.1	8	8	7	7	7	7	8
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✘	Charisma	Charisma II	Charisma II	✔	✔	✔	✔	✔	✔	✔
	✘	✘	Truform	Truform	✘	✘	✘	✘	✘	✘	✘
	✘	✘	2, SmartShader	2, SmartShader	2, nfiniteFX II	2, nfiniteFX II	✘	✘	✘	✘	2, nfiniteFX II
	✘	✘	SmartShader	SmartShader	nfiniteFX II	nfiniteFX II	✘	✘	✘	✘	nfiniteFX II
	Software based 2x, 4x	2x, 4x	2x, 3x, 4x, 5x, 6x	2x, 3x, 4x, 5x, 6x	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS	2x, Quincunx, 4x, 4xS
	✘	16 TAP	16 TAP	16 TAP	4 TAP	4 TAP	2 TAP	2 TAP	2 TAP	2 TAP	4 TAP
	✔	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘
	1	3	2	2	4	4	4	4	4	4	4
	2	2	4	4	4	4	2	2	2	2	4
	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit	32-bit
	350	500	920	1,000	1,100	1,200	540	540	500	540	1,200
	350	1,560	1,840	2,000	2,200	2,400	1,100	1,100	1,000	1,100	2,400
	16	40	75	78	125	136	34	34	31	34	136
	Out	In/out via splitter	In/out via splitter	Out	Out	Out	Out	Out	Out	✘	In/out via splitter
	Out via convertor	In/out	In/out	Out via converter	Out via converter	Out via converter	Out via splitter	✘	✘	✘	✘
	✘	✔	✔	✔	✔	✔	✘	✘	✘	✘	✔
	✘	RF antenna, 2nd D-SUB via adaptor	RF antenna, FireWire, 2nd D-SUB via adaptor	✘	✘	✘	✘	✘	✘	2nd D-SUB	✘
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	✔	✘	✘	✘	✔	✔	✘	✔	✔	✔	✔
	CyberLink PowerDVD 3	ATi DVD Player 7.5	ATi DVD Player 7.5	CyberLink PowerDVD XP 4	WinFast DVD	WinFast DVD	MSI DVD Player (InterVideo)	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4	CyberLink PowerDVD XP 4
	E-Color 3Deep	Ulead VideoStudio 5 SE, ATi Multimedia Centre 7.5	Ulead VideoStudio 5 SE, ATi Multimedia Centre 7.5	E-Color 3Deep	WinFox, Cult3D, 3Deep, Gunlok, DroneZ	WinFox, Cult3D, 3Deep, Gunlok, DroneZ	No-one Lives Forever, AquaNox, Sacrifice, E-Color 3Deep, Trend PC-cillin 2000, MSI 3D! Turbo Experience, GoodMEM, LockBox				CyberLink PowerDirector
	S-Video-to-composite convertor	Output splitter with S-Video, composite, S/PDIF and stereo out, input box with S-Video, composite, stereo RCA, DVI/D-SUB adaptor	RF remote control, USB receiver, breakout box with S-Video in/out, composite in/out, S/PDIF and stereo RCA in/out, FireWire, DVI/D-SUB adaptor	✘	S-Video-to-composite convertor, composite cable, S-Video cable	S-Video-to-composite convertor, composite cable, S-Video cable	S-Video cable	S-Video cable	✘	✘	S-Video in/out splitter
	24.1	44.2	54.3	69.5	78.9	83.7	43	44	24.1	43.4	84.1
	9.1	12.1	21.5	31	41.2	46.7	17.6	17.6	9.5	17.6	48
	37	38.9	46.3	49	73.8	77	51.9	54.4	29.9	52	76.6
	19.7	15.2	23.1	31.1	60.4	70	25.2	25.2	14.2	25.2	65.4
	2,276	3,411	5,294	6,052	7,587	7,944	4,110	4,108	2,556	4,095	8,000
	1,502	1,205	2,280	2,765	4,925	5,448	1,831	1,830	1,099	1,845	5,459
	8.9	14.7	22.4	35.3	38.8	42.3	16.8	16.9	10.2	16.5	42.5
	4.2	6.6	13.5	19.5	24.1	26.7	5.3	5.4	5.4	5.4	26.7

Abit Siluro GF4 Ti4400

PRICE £232 (£273 inc VAT)

SUPPLIER dabs.com 0800 138 5182

VERDICT One of the fastest performers in our tests, but it's let down by a lack of software, especially when you consider the price.

Many big motherboard manufacturers have only recently added graphics cards to their line-up, but Abit's Siluro range has been around for several years. The latest addition is the GF4 Ti4400, based not surprisingly on Nvidia's GeForce4 Ti 4400 GPU.

Running at 275MHz, it's certainly a fast GPU. On board is 128Mb of 550MHz DDR memory, which offers the second highest bandwidth on test of 8.8Gbits/sec. This gives the Ti4400 an advantage in high-resolution gaming. The Siluro GF4 scored 2.39 in our suite of tests, making the Ti 4400 the third fastest processor on test behind the Ti 4600 and Gainward's Ti 4600 Golden Sample.

Although Abit bundles a basic overclocking utility for increasing memory and core clock speeds, it provides no warranty if you use the program as Gainward does. Still, the memory chips are covered by heatsinks to give better overclocking potential.

The standard GeForce4 Ti combination of D-SUB, S-Video and DVI connectors adorn the backplate, and Abit adds value by including an S-Video/composite splitter, a DVI-to-D-SUB adaptor and both S-Video and composite video cables in the box.

The Siluro falls behind other Ti 4400 cards on software – its two colour-matching applets can't compete with the games bundles offered by Asus, Creative and Leadtek. If your budget won't stretch to the Ti 4600 cards and you really want a GeForce4 Ti 4400, choose the Leadtek WinFast A250 TD. It's £2 less, comes with two games and only lacks Abit's DVI-to-D-SUB adaptor.

PC PRO RESULTS
OVERALL
116
FEATURES	PERFORMANCE	VALUE
109	146	94
100 IS THE AVERAGE
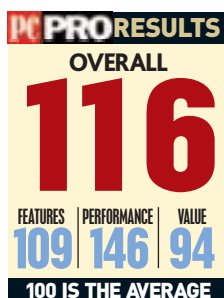
Asus V8440

PRICE £235 (£276 inc VAT)

SUPPLIER Micro Direct 0870 444 4456

VERDICT Another great performer thanks to the Ti 4400 GPU. The bundled software and cables add value, but there's little to choose between all the Ti 4400-based cards on test.

Early adopters of new technology always pay a premium, and buying into GeForce4 Ti technology will put a rather large dent in most bank balances. The first offering from Asus is based on the Ti 4400 chipset and, at £235, the V8440 is almost identically priced to the Abit Siluro GF4 Ti4400 and Leadtek WinFast A250 TD. The only Ti 4400 to drop below this price is the Creative, which weighs in at £213 but doesn't include a big software or accessories bundle.

One of the most important aspects of all three Ti variants is their full support for DirectX 8, Accuview and nView. Not only do you get fantastic performance in the latest games, but you can also enhance your existing games collection with full-scene anti-aliasing in 4xS mode while retaining playable frame rates. Plus, nView allows you to hook up a second TFT panel or CRT using the DVI output or the bundled DVI-to-D-SUB adaptor.

The only other accessory in the box is an S-Video/composite video splitter, which plugs into the S-Video socket on the card's backplate for output to a TV or video. The games bundle comprises the superb AquaNox and also Midnight GT, while a selection of Asus utilities, including an overclocking applet, adds more value.

As there's nothing to differentiate the four Ti 4400 cards physically, it's down to which accessories and software bundle takes your fancy. If you have no need for any, the Creative is a good choice; otherwise, the Leadtek A250 TD offers best value.

PC PRO RESULTS
OVERALL
116
FEATURES	PERFORMANCE	VALUE
112	145	93
100 IS THE AVERAGE
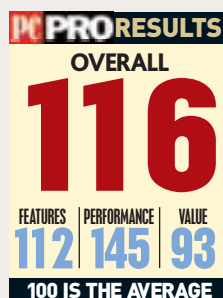
Asus V8460 Ultra

PRICE £311 (£365 inc VAT)

SUPPLIER Micro Direct 0870 444 4456

VERDICT The most expensive card on test is undoubtedly a fantastic performer, but it's beaten on value by other Ti 4600-based entries.

If you thought the Asus V8440 was expensive, it's probably best not to look at the V8460 Ultra's price. If you've not fainted, you'll be wondering whether the extra £76 over the V8440 is worth it. After all, this Ti 4600-based card uses essentially the same technology as the cheaper Ti 4400 and simply has faster core and memory clocks.

To be precise, the V8460 Ultra has a core of 300MHz with memory at an effective – and blistering – 650MHz, while the Ti 4400 is 25MHz and 100MHz slower respectively. Overall, though, the Ti 4600 only managed to pull ahead of the Ti 4400 by 0.2 in our benchmarks – a difference you'd be hard pushed to notice in the real world.

In spite of the V8460 Ultra's extra cost, the bundled accessories and software are identical to the V8440. Not that this is necessarily a bad thing. We always appreciate seeing AquaNox, while Asus' Tweak utility allows you to overclock the core and memory speeds. But, as there are no memory heatsinks, increases will be more limited than on other cards.

Like the V8440, the V8460's dual 350MHz RAMDACs allow two displays to be connected, and the DVI output guarantees a crystal-clear image on a TFT panel.

Unfortunately for Asus, the V8460 Ultra earns the dubious honour of being the most expensive card on test – Gainward's Ti 4600 card is over £10 cheaper yet includes a FireWire card and is a better performer.

In fact, the Ultra/750 XP beat it by a clear margin in all of our eight tests. Unless the V8460 Ultra's price drops down to a more reasonable level, the choice is all too obvious.
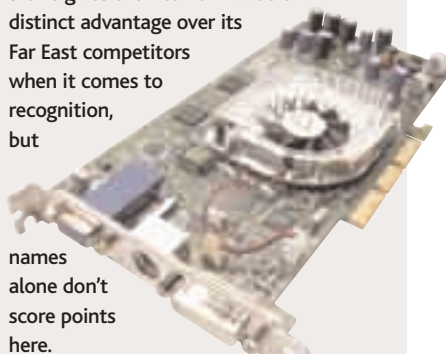
PC PRO RESULTS
OVERALL
114
FEATURES	PERFORMANCE	VALUE
112	157	75
100 IS THE AVERAGE
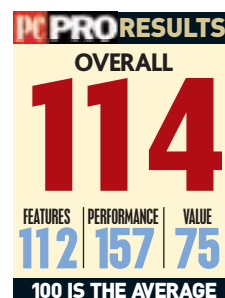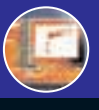
Creative 3DBlaster 4 Titanium 4400

PRICE £213 (£250 inc VAT)

SUPPLIER Jungle.com 08000 355 3555

VERDICT With a poor software and accessories bundle, the Creative is more akin to an OEM card than a retail one. It is the cheapest Ti 4400 on test, though.

Creative has manufactured graphics cards for far longer than most players in this Labs. The Creative brand gives the Titanium 4400 a distinct advantage over its Far East competitors when it comes to recognition, but names alone don't score points here.

The Titanium 4400 uses the standard clock speeds of all the Ti 4400-based cards – a core clock of 275MHz and an effective memory clock of 550MHz. This gives an 8.8Gbits/sec memory bandwidth – one of the best on test. Creative doesn't supply an overclocking utility with its card, but many would argue that it's unnecessary given the extraordinary performance as standard (*see Performance analysis, p78*).

The 3DBlaster's connectivity is lacking in one aspect: there's no DVI-to-D-SUB convertor for attaching a second CRT. Interestingly, Creative is the only vendor not to include a DVD player as part of the software bundle. This makes sense if DVD software was bundled with your DVD-ROM drive – why pay twice for the same thing? Incoming and eRacer are included, though the latter isn't a full version.

Only price and the additional bundle separates the four Ti 4400 cards, as performance is identical. Compared to the Leadtek A250 TD, which costs £17 more, the Creative lacks software and overclocking potential, making the former a better deal if you like the look of Leadtek's games and accessories bundle.

PRO RESULTS
OVERALL
113
FEATURES	PERFORMANCE	VALUE
99	144	100
100 IS THE AVERAGE

Gainward GeForce4 PowerPack! Ultra/650 TV/DVI

PRICE £139 (£163 inc VAT)

SUPPLIER Simply 0870 727 2100

VERDICT Superb performance and features, and a fantastic price make this the graphics card to buy. A great debut for the Ti 4200.

Just when the dust seems to have settled after the recent launch of the GeForce4 graphics card family, Nvidia has thrown yet another spanner in the works. While the GeForce4 MX is a high-value proposition, it lacks the crucial Pixel and Vertex Shader support of the GeForce4 Ti. Striking a balance between the two is the new GeForce4 Ti 4200, boasting the full range of features found in the top-end cards, but costing around half the price.

In terms of performance, the Ti 4200 slots in between the MX 460 and Ti 4400, meaning this Gainward board offers the same 2D and 3D features as the Ultra/750 XP, but for a bargain price. This is achieved by reducing memory and core clock speeds and also, significantly, by reducing the amount of on-board memory from 128Mb to 64Mb. For most people, the drop will make absolutely no difference – the benefit of the 128Mb will only be realised at very high resolutions with anti-aliasing enabled.

The clocks speeds are the lowest of the Ti boards, running at 250MHz for the core and 500MHz for the memory. Even so, the GeForce4 Ti 4200 flew through our tests, scoring a mighty 2.2. This level of performance is unprecedented at this price point, beating the more expensive Radeon 8500-based cards.

Despite being the non-Golden Sample version of the Ultra/650, this Ti 4200 is fantastic value. It delivers near cutting-edge performance at an affordable price. Our advice is to buy one.

PRO RESULTS
OVERALL
127
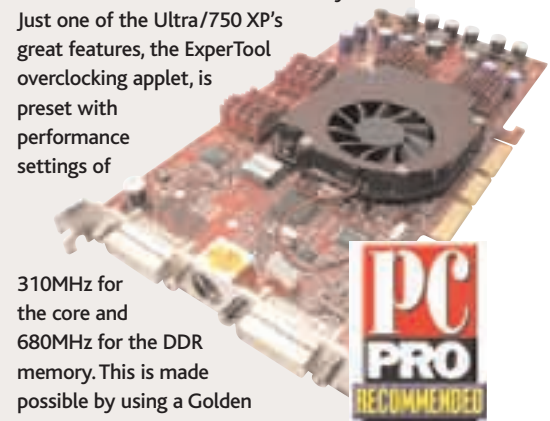| FEATURES	PERFORMANCE	VALUE
112	134	142
100 IS THE AVERAGE

Gainward GeForce4 PowerPack! Ultra/750 XP Golden Sample

PRICE £300 (£353 inc VAT)

SUPPLIER Simply 0870 727 2100

VERDICT It's pricey, but delivers amazing performance and features, and still costs less than other Ti 4600 cards.

Gainward is well known for its overclockable graphics cards and remains unique in allowing users to overclock their cards within warranty. Just one of the Ultra/750 XP's great features, the ExperTool overclocking applet, is preset with performance settings of 310MHz for the core and 680MHz for the DDR memory. This is made possible by using a Golden Sample GPU – a hand-picked GeForce4 Ti 4600 that is able to reach higher speeds than other chips. The same cherry-picking technique is used for the RAM, allowing it to run faster while remaining stable.

The Ultra/750 returned a searing score of 2.68. The standard GeForce4 Ti 4600 cards managed 2.6, but Gainward has managed to price its card lower than most other Ti 4600 offerings. On top of this, a three-port FireWire card is bundled, hinting at the card's video-editing capabilities. A splitter is provided for both S-Video and composite input along with InterVideo editing software – the VisionTek Ti4600 is the only other Ti to implement video capture. Uniquely, the Ultra/750 XP has twin DVI outputs, while two D-SUB adaptors are included for dual-monitor possibilities.

The PowerPack is the ultimate gamers' graphics card. It's bursting with features, beats all-comers on speed and undercuts its rivals on price.

PRO RESULTS
OVERALL
123
FEATURES	PERFORMANCE	VALUE
124	163	82
100 IS THE AVERAGE
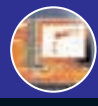
Gigabyte Maya AP Radeon 8500 Deluxe

PRICE £188 (£221 inc VAT)

SUPPLIER dabs.com 0800 138 5182

VERDICT The 8500 Deluxe is a superb performer with full DirectX 8.1 support, but is upstaged by the 8500 Pro, which offers better value at £137.

ATi has finally realised that Nvidia's strategy of licensing its chipsets out to other board manufacturers is a good idea. You can't buy ATi-branded cards any more, but Gigabyte, Hercules and several other partners offer the full ATi range between them.

The Maya AP Radeon 8500 Deluxe is one of Gigabyte's top-end graphics cards – only the 128Mb version is higher. This 64Mb DDR card runs with standard 8500 clocks – 275MHz core and 550MHz memory. It scored a respectable 1.99 in our benchmarks, not too far behind the GeForce4 Ti 4200 chipset.

In real terms, it means that the 8500 Deluxe will happily run cutting-edge titles, and you should also be able to use its 4x anti-aliasing support at resolutions up to XGA – no mean feat. Plus, with its hefty heatsinks, you should be able to overclock the card using the bundled V-Tuner application. Just bear in mind that Gigabyte won't replace the card if you damage it while overclocking.

Like most of the other ATi-based cards on test, the 8500 Deluxe has both D-SUB and DVI outputs, so you can connect two monitors and use the HydraVision software to create an Extended Desktop. There's a DVI-to-D-SUB adaptor in the box for a second CRT connection, and the obligatory S-Video output is also present.

Taking into account the bundled games – including Serious Sam – and PowerDVD XP 4, the 8500 Deluxe offers reasonable value and is packed with features. But, the Gainward Ti 4200 offers considerably better performance for almost £50 less.

PC PRO RESULTS
OVERALL
115
FEATURES **120** | PERFORMANCE **121** | VALUE **104**
100 IS THE AVERAGE
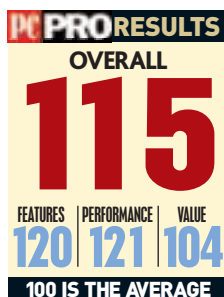
Gigabyte Maya AP Radeon 8500 Pro

PRICE £137 (£161 inc VAT)

SUPPLIER dabs.com 0800 138 5182

VERDICT Great overclocking potential, thanks to a massive heatsink and fan – the best Radeon-based card around.
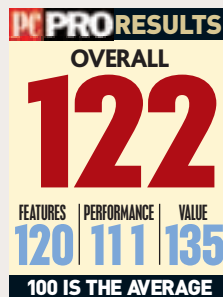
Place the 8500 Pro and 8500 Deluxe side by side and you'll have trouble telling them apart. The only feature that distinguishes the two is a small sticker on the Deluxe bearing the letter H. It isn't simply looks either. Both cards are identical aside from their clock speeds – the Pro's core and memory run at 250MHz and the Deluxe's at 275MHz. For this reason, the GPU in the Pro is called an 8500LE, but there's no difference in features.

Scoring 1.85 overall, the Radeon 8500LE is hot on the heels of the 8500, and you'd see little difference when playing the same games on each card. The huge heatsink, which covers both sides of the card, has a large fan to keep temperatures down. This offers greater overclocking potential than Hercules' 3D Prophet FDX 8500 LE, which doesn't have heatsinks on the memory chips.

Using the V-Tuner performance tweaker, we successfully overclocked the 8500 Pro's core and memory speeds to 275MHz – the same as the Radeon 8500. As you'd expect, it then managed the same score as the 8500 Deluxe, saving £51 in the process.

Surprisingly, the bundled software and accessories mirror the 8500 Deluxe exactly, so you don't lose out here either. Even if you're not happy about overclocking the card – which voids the warranty – the 8500 Pro still offers excellent performance and much better value for money than any other 8500-based card on test here.

PC PRO RECOMMENDED

PC PRO RESULTS
OVERALL
122
FEATURES **120** | PERFORMANCE **111** | VALUE **135**
100 IS THE AVERAGE

Gigabyte Maya AR Radeon 7500 Pro

PRICE £71 (£83 inc VAT)

SUPPLIER dabs.com 0800 138 5182

VERDICT Acceptable 3D performance for today's games, but limited for the future. Best suited to those who need dual monitor support on a budget.

The third of Gigabyte's four entries into this Labs is based on the Radeon 7500LE chipset. Oddly, Gigabyte has chosen to use SDR rather than DDR RAM in the 7500 Pro, reducing memory bandwidth. The core runs at 230MHz, with memory set at 170MHz. The 7500LE GPU lacks the DirectX 8 support of the 8500, so it doesn't have programmable Pixel or Vertex Shaders. This limits its future, but at £71 the 7500 Pro won't break the bank.

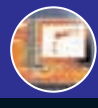With an overall score of 0.65 in our tests, the 7500LE is faster than the Radeon 7000, but it's still considerably slower than our reference GeForce2 Ultra. The latest games should be playable at lower resolutions – possibly even XGA – but the 7500LE GPU will slow to a crawl using 4x anti-aliasing at XGA.

Four full game titles are included in the package along with a couple of useful utilities, but it's unlikely that overclocking will reap any great performance boost in games.

One of the 7500 Pro's strengths is its DVD playback quality. Thanks to ATi's iDCT hardware acceleration and per-pixel adaptive deinterlacing, DVDs look sharp on the Maya AR. Gigabyte bundles a long S-Video/composite splitter for output to a large TV, and there's a DVI connector for hooking up a digital flat panel using HydraVision.

If you need a DVI output or dual monitor support, the Maya AR Radeon 7500 Pro offers good value for money and decent 2D capabilities.

PC PRO RESULTS
OVERALL
85
FEATURES **90** | PERFORMANCE **39** | VALUE **125**
100 IS THE AVERAGE
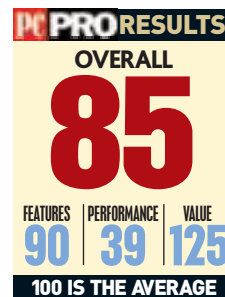
Gigabyte Maya AV Radeon 7000 Pro
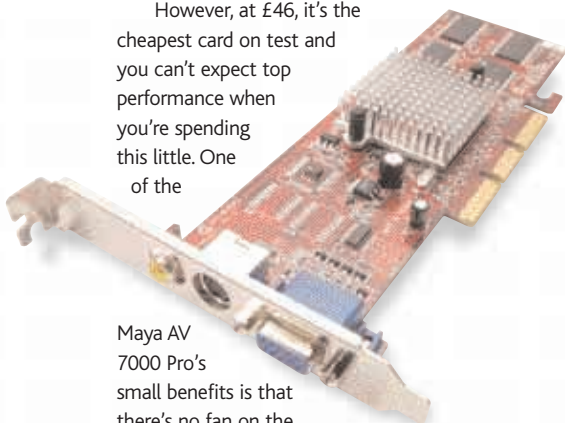
PRICE £46 (£54 inc VAT)
SUPPLIER dabs.com 0800 138 5182
VERDICT This outdated GPU is left for dust where performance is concerned. Only those looking specifically for a quiet card should buy it.

The last Gigabyte card to be installed in our test bed was the Radeon 7000 Pro. This is simply a RadeonVE, which is based on a cut-down version of the original Radeon R100 GPU. The 7000 Pro has 64Mb of SDR memory, which only runs at 155MHz, so it was no surprise to find that it was a poor performer in our tough benchmarks.

In fact, it was the slowest card on test, scoring a miserable 0.19 overall. It failed to deliver playable frame rates in any of our game benchmarks – 9.2fps in Serious Sam was the best performance we saw – so you would have to set gaming resolutions to their minimum, and even then the 7000 Pro would struggle to reach 30fps.

However, at £46, it's the cheapest card on test and you can't expect top performance when you're spending this little. One of the Maya AV 7000 Pro's small benefits is that there's no fan on the heatsink, so it won't increase your PC's noise output.

Another bonus is that it's a half-height card – it's only a shame that Gigabyte doesn't take advantage of this by including a half-height mounting bracket in the box that you could swap for the full-height version.

What you do get is an S-Video cable and a small bundle of games along with an overclocking utility. But this isn't enough to make the 7000 Pro worth buying – the altogether better Maya AR 7500 Pro will only cost you an extra £25. But if your budget can stretch to £86, MSI's G4MX440-T is well worth considering.

PC PRO RESULTS
OVERALL
61
FEATURES **68** | PERFORMANCE **12** | VALUE **101**
100 IS THE AVERAGE
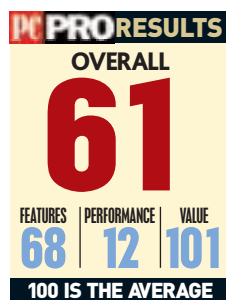
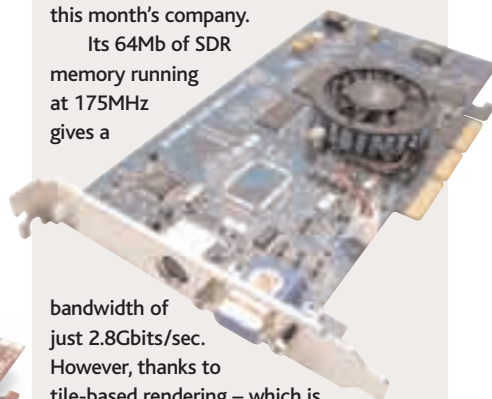# Hercules 3D Prophet 4500

PRICE £94 (£110 inc VAT)
SUPPLIER Jungle.com 08000 355 3555
VERDICT The 4500 is an overpriced budget card with a poor bundle, inferior to the much faster GeForce4 MX cards.

PowerVR's original Kyro chip soured the relationship between Hercules and Nvidia, and the Kyro II continued the feud. Although based on the later GPU, the 4500 is over a year old now. Designed to compete with GeForce2 MX cards, and not the latest GeForce4 MX, it struggles in this month's company.

Its 64Mb of SDR memory running at 175MHz gives a bandwidth of just 2.8Gbits/sec. However, thanks to tile-based rendering – which is effectively occlusion culling – the Kyro II chip doesn't need massive amounts of memory or bandwidth to achieve its performance.

But the 4500's overall score of 0.61 in our benchmarks was one of the poorest on test. It was roughly equal to the Radeon 7500LE, but the GeForce4 MX 440 cards, which cost about the same as the 3D Prophet, scored 0.97.

The 4500 has adequate DVD playback capability, but don't expect the same quality as ATi or Nvidia GeForce4 cards. While alpha subpicture blending is carried out in software, the Kyro II has hardware acceleration for motion compensation and per-pixel adaptive deinterlacing.

With only CyberLink's PowerDVD 3 player included, the 4500 was never going to get a high features score. A year ago, this would have been a worthy contender for a Value award. Now, with MX 440 cards costing roughly the same but with better performance and features, the Kyro II is fast becoming obsolete.

PC PRO RESULTS
OVERALL
51
FEATURES **48** | PERFORMANCE **37** | VALUE **70**
100 IS THE AVERAGE
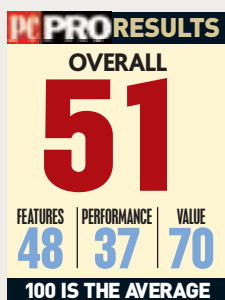
Hercules 3D Prophet All-in-Wonder 7500

PRICE £149 (£175 inc VAT)
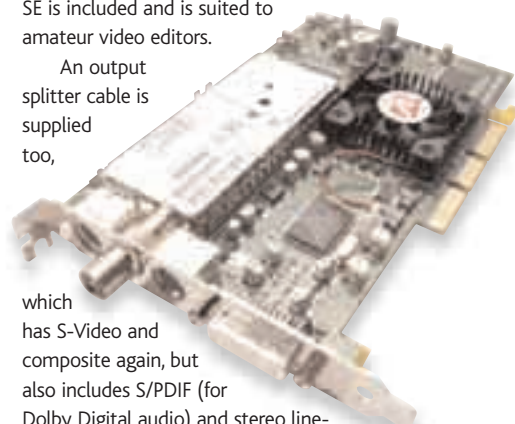**SUPPLIER** Jungle.com 08000 355 3555
VERDICT Although not as fully featured as its bigger 8500 brother, the All-in-Wonder 7500 is significantly cheaper yet offers plenty of features.

With ATi now starting to ape Nvidia's business model, Hercules has achieved a coup as the exclusive distributor of the All-in-Wonder cards, although ATi still provides the software and accessories.

Those familiar with the All-in-Wonder concept will know that 3D performance isn't its primary focus. It's designed to be a jack-of-all-trades, able to capture video streams, receive TV signals and play DVDs in addition to offering the latest 3D GPUs for gaming.

Taking care of video capture are sockets for both S-Video and composite video alongside stereo RCA jacks for audio, all mounted on a convenient breakout box. Ulead VideoStudio 5 SE is included and is suited to amateur video editors.

An output splitter cable is supplied too, which has S-Video and composite again, but also includes S/PDIF (for Dolby Digital audio) and stereo line-out. HydraVision support is another important, new feature of the latest All-in-Wonder range.

The updated Multimedia Centre is a great improvement over older versions, but Windows Media Player already covers much of its functionality. The DVD player takes advantage of all the hardware features, and the TV application can now be manually tuned, making it far easier to connect VCRs and more.

Although the All-in-Wonder 8500 DV has two FireWire connectors and an RF remote, the 7500 costs a whopping £132 less. So if you're after a basic all-in-one AGP card and aren't too fussed about 3D performance, the All-in-Wonder 7500 is well worth considering.

PC PRO RESULTS
OVERALL
83
FEATURES **114** | PERFORMANCE **50** | VALUE **76**
100 IS THE AVERAGE
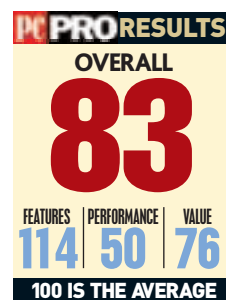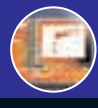
Anti-aliasing explained

Now that frame rates have reached such amazing heights, graphics chip designers are turning their attention to image quality. We explain how

High-end graphics cards for professional CAD/CAM use have featured anti-aliasing for some time. However, recently it has become an important aspect in consumer 3D too, due to the demand for better image quality along with performance. Simply put, anti-aliasing is a way of reducing jaggies – the stair-step effect that can be seen on the edges of polygons in a 3D scene.

Aliasing occurs when there aren't enough pixels to represent a smooth line at typical resolutions, such as 1,024 x 768. Increasing the resolution increases the pot of pixels to play with, but this isn't always possible, mainly because some monitors simply can't attain the higher resolutions – a problem that affects TFTs more than CRTs.

There are several ways of anti-aliasing, from calculation-intensive edge-anti-aliasing to the more common FSAA (Full Scene Anti-Aliasing) first implemented by 3dfx. Today's cards generally fall into two categories – Supersampling and Multisampling. Both are algorithmic approaches, requiring some GPU calculations, although there are fundamental differences.

SUPERSAMPLING

Supersampling anti-aliasing is used by Nvidia's GeForce2 series and ATi's Radeon 7000 series. A subpixel mask is applied to a scene, which is then rendered internally at a higher resolution. The two most common types of anti-aliasing are 2x and 4x anti-aliasing, with screen resolutions multiplied by 2.25x (1.5x in the x and y axis) and 4x (2x in the x and y axis)

respectively. So at 800 x 600 with 4x anti-aliasing, the scene is rendered internally at 1,600 x 1,200, with each pixel of the original scene subdivided into four subpixel samples.

The higher resolution scene (which is filtered back to the original resolution for display) determines the pixel colours of the final image.

Each of the four subpixel samples contains separate colour data, so the final pixel colour is determined by blending the samples. This blurs transition boundaries, which appear less jagged.

Supersampling works well, but its implementation is very demanding on hardware. As the scene is rendered at the higher resolution internally – each sample has separate colour and z values – fill-rate (the rate that pixels are drawn into the screen memory) and bandwidth requirements are increased enormously. At high resolutions with 4x anti-aliasing or higher, Supersampling can severely affect performance.

ATi's SmoothVision anti-aliasing subsystem, featured in the Radeon 8500, also uses a Supersampling approach, although the implementation is different. In Performance mode, SmoothVision varies the number of samples taken per pixel and uses a jittered sample pattern – randomising where samples are taken from – instead of an ordered grid. The argument is that the eye sees orderly patterns easily, so a non-ordered pattern is harder to spot. SmoothVision also employs more sophisticated scaling and filtering algorithms to improve performance further.

MULTISAMPLING

Microsoft added support for Multisampling in its DirectX 8 API to try and solve some of these problems. The first card to take advantage of this was Nvidia's GeForce3 family.

Like Supersampling, Multisampling increases the resolution internally by a fixed factor. However, rather than scale the scene up, it stores copies of the scene, which are slightly shifted in the x and y axis.

The colour value for each subpixel is derived from a single texel fetch instead of individual fetches for each subsample, reducing bandwidth requirements. However, averaging the colour of each sample doesn't produce a blended colour, so Multisampling concentrates on subpixel edge coverage. For a simple 4x anti-aliasing example, where the weighting of each subpixel is the same, if a polygon edge falls within two of the four samples the final colour will have an intensity of 50 per cent.

The process leaves textures untouched, while every pixel is rendered in Supersampling. Texture quality can suffer compared to Supersampling techniques, although increasing texture filtering can balance this out.

Nvidia has a Quincunx mode that uses a five-sample point pattern. However, rather than generate five samples, Quincunx generates two and uses a reconstruction filter to sample data from three neighbouring pixels. Results are between 2x and 4x modes while only using the same bandwidth as in 2x mode.
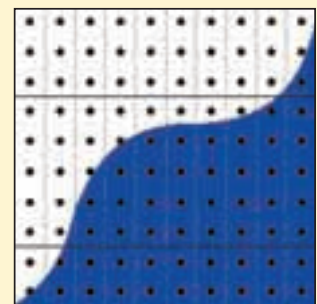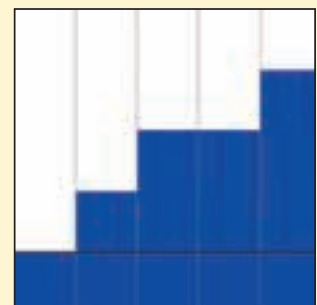
GARETH OGDEN
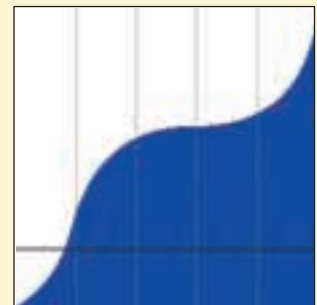
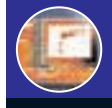This is the curve before being rendered into pixels.
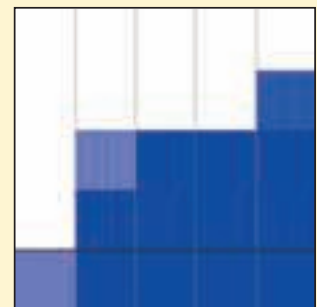
The rendered curve after 4x supersampling has been applied.

The curve with a four subsample per pixel mask (dots represent sample locations).

How the curve would look, rendered in a 5 x 5 grid.

Hercules 3D Prophet All-in-Wonder 8500 DV
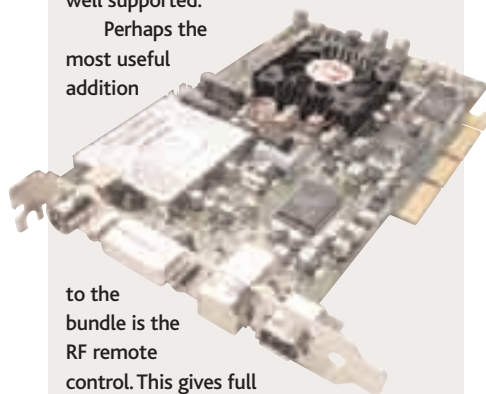
PRICE £281 (£330 inc VAT)
SUPPLIER Jungle.com 08000 355 3555
VERDICT Superior 3D performance and features to the All-in-Wonder 7500, and the RF remote is great for TV and DVD playback control, but it's expensive.

Leading the charge in Hercules' new Radeon-based range is the All-in-Wonder 8500 DV. It's based on the 8500 GPU and does much more than simply play the latest 3D titles. There's an on-board TV tuner, good-quality video capture and top-notch DVD playback.

The 8500 DV is a better proposition than the All-in-Wonder 7500 for gaming – it scored 1.39 overall in our benchmarks. This is worse than a standard 8500 due to its lower clock speeds of 230MHz and 380MHz for core and memory respectively. But support for the full set of DirectX 8.1 instructions means future games will be well supported.

Perhaps the most useful addition to the bundle is the RF remote control. This gives full control of ATi's Multimedia Centre and can even be used to control the mouse cursor – ideal for watching TV and DVDs. Plus, as it doesn't use infrared, you don't need line of sight to the USB receiver. Also included is the obligatory breakout box, which allows video and audio connections to be made without having to reach behind the PC.

If you're considering video editing and don't already have a FireWire port, the 8500 DV is a tempting offer. 3D performance is acceptable, but this card is more concerned with the rest of its strong features.

PRO RESULTS
OVERALL
102
FEATURES **147** | PERFORMANCE **84** | VALUE **59**
100 IS THE AVERAGE

Hercules 3D Prophet FDX 8500 LE
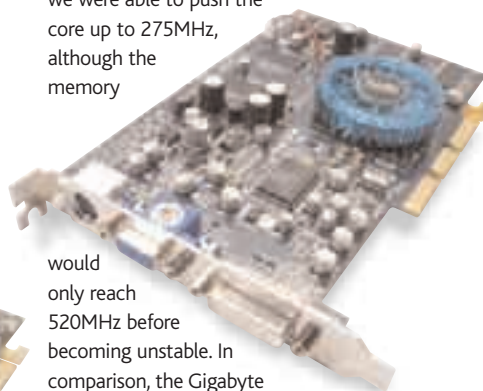
PRICE £128 (£150 inc VAT)
SUPPLIER Jungle.com 08000 355 3555
VERDICT Another decent performer, thanks to the Radeon 8500 LE chipset, but the Gigabyte Maya AP Radeon 8500 Pro is a better all-round package.

The final card from the Hercules stable this month is based on a slightly handicapped version of the 8500 chipset. The limitations are just in terms of the clock speeds of the core and memory – 250MHz and 500MHz respectively. On the plus side, this makes it significantly cheaper than the Gigabyte Maya AP Radeon 8500 Deluxe, which uses the usual 275MHz/550MHz clocks.

Using Hercules' bundled overclocking utility, we were able to push the core up to 275MHz, although the memory would only reach 520MHz before becoming unstable. In comparison, the Gigabyte Maya AP Radeon 8500 Pro remained stable at 275MHz for core and 550MHz for memory. In Hercules' case, this still gave a useful boost in performance, increasing the overall *PC Pro* score from 1.86 to 1.93. However, remember that overclocking the card will void the warranty.

On the backplate are all the connectors we'd expect; there are S-Video and DVI outputs alongside the obligatory D-SUB. What's more, adaptors are supplied to convert from S-Video to composite and from DVI to D-SUB. However, the only software included with the FDX 8500 LE is a colour-correction utility and CyberLink PowerDVD XP.

The Gigabyte Maya AP Radeon makes a better overall purchase with its large games pack and greater overclocking potential. But the best deal in this Labs is clear. Gainward's GeForce4 PowerPack! Ultra/650 has the magic combination of price and performance, and not even the budget 8500LE-based cards can beat it.

PRO RESULTS
OVERALL
118
FEATURES **105** | PERFORMANCE **113** | VALUE **140**
100 IS THE AVERAGE

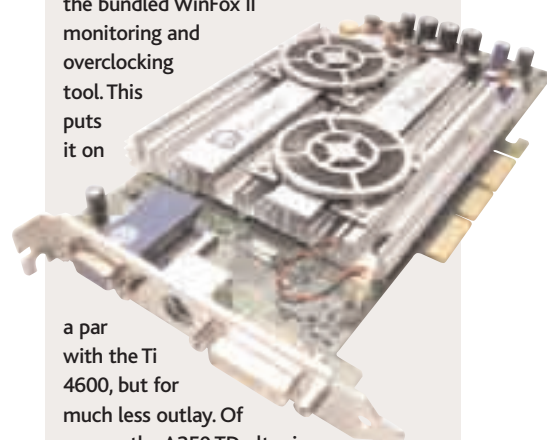# Leadtek WinFast A250 TD

PRICE £230 (£270 inc VAT)
SUPPLIER dabs.com 0800 138 5182
VERDICT Leaving the majority of cards in its wake, the A250 TD also has fantastic overclocking potential.

Leadtek has long been associated with Nvidia – since the days of the Riva TNT chipset, in fact. The first of the two offerings is based on the Ti 4400 chipset.

Although shipped at the standard clock speeds of 275MHz for the core and an effective 550MHz for the 64Mb of DDR memory, the A250 TD has the largest heatsink we've ever seen on a graphics card. As well as this expanse of metalwork, there are two fans mounted on the top. In combination, these allow plenty of overclocking potential, but this would void the warranty if any damage were caused.

As standard, the Ti 4400 scored 2.39 overall in the *PC Pro* test suite, but we managed to increase this to 2.59 using the bundled WinFox II monitor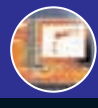ing and overclocking tool. This puts it on a par with the Ti 4600, but for much less outlay. Of course, the A250 TD ultra is similarly overclockable, with its identical heatsink.

On the A250 TD's backplate are three connectors: DVI, D-SUB and S-Video. Also in the box are S-Video and composite cables – only Abit is similarly generous. The software includes full games in the form of Gunlok and DroneZ.

The feast of extras and competitive price mean that Leadtek's A250 TD is the best of Ti 4400 bunch. Only Gainward's Ti 4200 ruins its party.

PRO RESULTS
OVERALL
119
FEATURES **116** | PERFORMANCE **145** | VALUE **96**
100 IS THE AVERAGE

Leadtek WinFast A250 Ultra TD

PRICE £300 (£353 inc VAT and postage)

SUPPLIER dabs.com 0800 138 5182

VERDICT A fast card with great overclocking potential, but this voids the warranty, so the Recommended award goes to Gainward's alternative.

What does £70 and an 'Ultra' badge buy you? In the case of the two Leadtek cards, the answer is an extra 0.21 in the *PC Pro* 3D performance rating.

A quick look at the feature table reveals minimal specification changes. Perhaps the most noticeable are the Ultra's memory and core clock speeds – which run at 300MHz and an effective 660MHz – appreciably more than the 275MHz and 550MHz of the A250 TD.
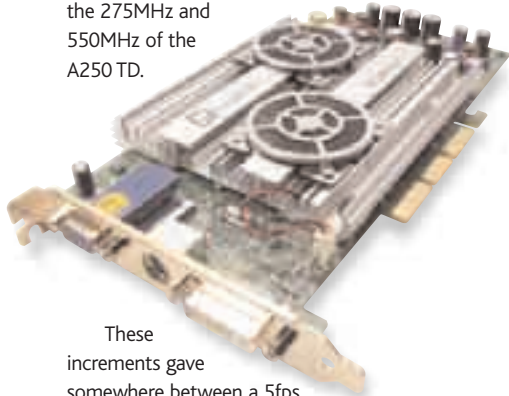
These increments gave somewhere between a 5fps and 10fps advantage in the games we tested with. This is obviously an improvement, but you wouldn't be able to tell the difference in most of today's games. The same huge heatsink and dual fans of the A250 TD are fitted and these allowed us to overclock the card to Gainward's Ultra/750 XP Golden Sample speeds, but without the warranty.

Software and accessories are identical to the A250 TD, including two games and a DVD player alongside the DVI-to-D-SUB converter and, again, the games only add value if they are to your taste – otherwise they're likely to be left in the box.

If you want outright performance, the Ultra TD will match the Gainward if you're happy to overclock it, but the Ultra/750 XP Golden Sample comes with a FireWire card and 3D glasses for the same price. But, if you can live with lower performance and want DirectX 8 features, the Gainward Ti 4200 is the obvious choice in this Labs.

PC PRO RESULTS

OVERALL

117

FEATURES	PERFORMANCE	VALUE
116	158	78

100 IS THE AVERAGE

MSI G4MX440-T

PRICE £86 (£102 inc VAT)
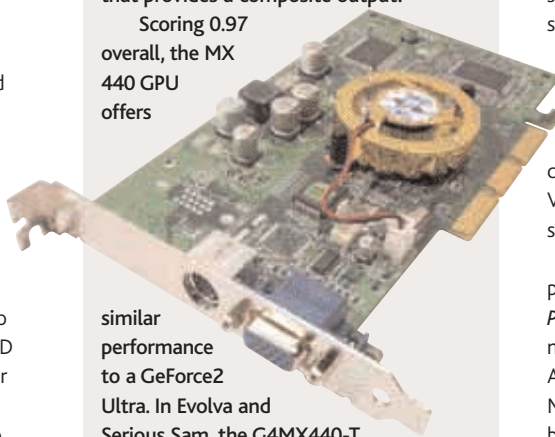
SUPPLIER Micro Direct 0870 444 4456

VERDICT The best GeForce4 MX440-based card on test, thanks to a decent software bundle and low price.

Following in the footsteps of Abit, Asus and Gigabyte, Micro-Star International is another motherboard manufacturer that has recently added graphics cards to its line-up. But in such a competitive market, MSI has to work hard to make its graphics cards stand out from the crowd.

Thankfully, the G4MX440-T manages to do just this. Although it's essentially a standard GeForce4 MX 440 card with 64Mb of DDR memory, the G4MX440-T makes its mark with a decent software bundle without an increased price. It includes three full games – AquaNox, No-one Lives Forever and Sacrifice, plus several useful utilities.

GoodMEM is a handy application that displays the amount of physical free memory on the taskbar and can also free up memory when required. The 3D! Turbo Experience is MSI's overclocking utility, but the lack of a decent heatsink and fan will limit performance increases. MSI also includes a 2m S-Video cable and a splitter that provides a composite output.

Scoring 0.97 overall, the MX 440 GPU offers similar performance to a GeForce2 Ultra. In Evolva and Serious Sam, the G4MX440-T returned over 40fps at SXGA, and at XGA with 4x anti-aliasing enabled it delivered 25fps. AquaMark was tougher, and 16.8fps at SXGA wasn't a great result.

The lack of DirectX 8 support is one of the MX 440's stumbling blocks, but if you're after a budget gaming card and don't need a DVI output the MSI G4MX440-T should be high on your shortlist.

PC PRO RESULTS

OVERALL

90

FEATURES	PERFORMANCE	VALUE
87	59	127

100 IS THE AVERAGE

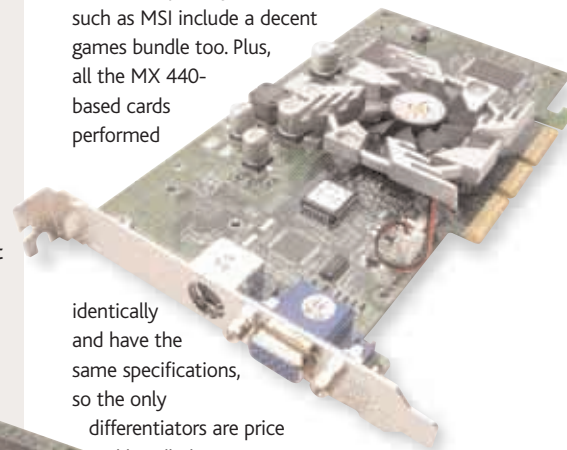# Sparkle SP7100M4 GeForce4 MX440

PRICE £90 (£106 inc VAT)

SUPPLIER Micro Direct 0870 444 4456

VERDICT Sparkle's card lacks the extras to compete with other GeForce4 MX 440 cards, making value for money distinctly average.

Sparkle has only recently moved into the retail market, previously being an OEM-only supplier. It may need to rethink its naming strategy, but this retail kit does include a couple of extras in CyberLink's PowerDVD XP 4 and an S-Video cable to accompany the GeForce4 MX 440 GPU.

These extras aren't great incentives to buy the card, especially when other manufacturers such as MSI include a decent games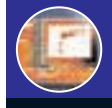 bundle too. Plus, all the MX 440-based cards performed identically and have the same specifications, so the only differentiators are price and bundled accessories.

Although the Sparkle costs only £4 more than the MSI G4MX440-T, the £10 delivery charge is again £4 more than the MSI's. VisionTek's MX 440 offering is even more spartan yet costs £98 and £8 for delivery.

In isolation, the Sparkle is a decent performer for the money, scoring 0.97 in the *PC Pro* suite of tests. It will run current games with no problems, unless you want to use the Accuview anti-aliasing. Of course, the GeForce4 MX 440 is essentially a DirectX 7 card, so the benefits offered by the GeForce4 Ti and Radeon 8500 are missing here (*see Performance Analysis, p78*).

Neither Sparkle nor VisionTek include an overclocking utility with their cards, but you can download a shareware version of PowerStrip from **www.entech taiwan.com**, which is one of the best overclocking programs available. But the bottom line is that the MSI offers better value for money, leaving the Sparkle in the cold.

PC PRO RESULTS

OVERALL

80

FEATURES	PERFORMANCE	VALUE
70	59	113

100 IS THE AVERAGE

VisionTek Xtacy GeForce 4 MX 420

PRICE £85 (£100 inc VAT)
SUPPLIER Data Pro 0161 483 9994
VERDICT A paltry bundle, alongside the poor performance, keeps us from recommending this card. You'd be better off opting for the MSI G4MX440-T.

VisionTek is a large, US graphics card company with 38.5 per cent of the retail market across the pond. It's starting its European operation with Nvidia's new GeForce4 chips, and this is the low-end MX 420 version.

It's clocked at 250MHz for the core and uses SDR memory running at 166MHz. This gives one of the lowest bandwidths this month at just 2.7Gbits/sec. The only card with a narrower bandwidth is the Radeon 7000-based card from Gigabyte, with 2.5Gbits/sec.

Obviously, this Xtacy isn't designed as a performance card – the key is value. Unfortunately, it only managed 0.60 overall in our benchmarks, yet costs almost the same as MSI's MX 440 card.

As you'd expect from a budget card, there's no DVI output, just D-SUB and S-Video out are represented. The software bundle is simply CyberLink PowerDVD XP 4, while MSI includes a decent bundle and faster GPU for £1 more.

The lack of features and poor performance make the VisionTek Xtacy GeForce 4 MX 420 a poor choice. We thought MX 420 cards would be much cheaper than those based on the MX 440, but with performance on a level with the Kyro II it's worth spending extra on an MX 440.

However, none of the MX-based cards support DirectX 8, so it might make sense to stretch to a card based on a Radeon 8500 or Nvidia's Ti 4200 GPU.

PC PRO RESULTS
OVERALL
61
FEATURES	PERFORMANCE	VALUE
63	36	85
100 IS THE AVERAGE
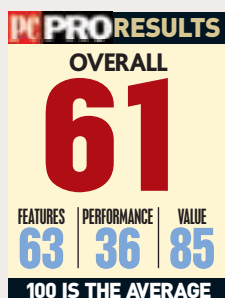
VisionTek Xtacy GeForce4 MX 440

PRICE £98 (£115 inc VAT)
SUPPLIER Data Pro 0161 483 9994
VERDICT Like the MX 420, the MX 440 is underbundled. The MSI version may not have the six-year warranty, but the software supplied is worth much more.

In common with the other two VisionTek cards, the MX 440 is rather overpackaged. Inside the large box, a hinged plastic case takes up all the space, with the card and CDs tucked into recesses. We can understand the shelf presence argument, but for such a small, inexpensive product this seems over the top.

With DDR memory and clocks that little bit higher than the MX 420 card from VisionTek's range, the MX 440 offers adequate performance. Still, it didn't make it into the top half of this month's cards in terms of performance-per-pound. This isn't surprising when MSI's version of the MX 440 is £12 cheaper.

The one area where the VisionTek MX 440 stands out is its outputs. While it includes neither S-Video nor DVI sockets, it's the only card to have two D-SUB outputs. This limits you in terms of quality when connecting to TFTs, but most people use dual CRTs, so not having to use a DVI-to-D-SUB adaptor is a benefit.

Unfortunately, the software bundle is as lacklustre as the MX 420's offering, with just a DVD player. Perhaps it's the six-year warranty that adds such a significant amount to the price, but anyone keeping a 'performance' 3D graphics card in service for that long is going to be way behind the times.

The VisionTek MX 440 isn't much better in terms of value for money than its MX 420 version. MSI's attempt has a much better software bundle and costs a few pounds less – two very good reasons for avoiding VisionTek's card.

PC PRO RESULTS
OVERALL
74
FEATURES	PERFORMANCE	VALUE
65	59	100
100 IS THE AVERAGE
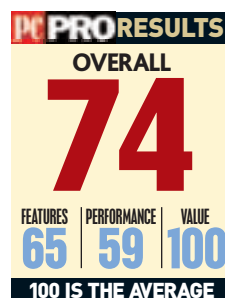
VisionTek Xtacy GeForce4 Ti 4600

PRICE £306 (£360 inc VAT)
SUPPLIER Amazon International 0141 776 3399
VERDICT Unless you can find it cheaper than the Gainward, the Xtacy Ti 4600 hasn't got much going for it other than great performance.

As the flagship of VisionTek's incursion into the European market, the Ti 4600 is based on the most powerful of Nvidia's new GPU line-up. Clocked at the standard speeds of 300MHz for the core and an effective 650MHz for the 128Mb of DDR SDRAM, the memory bandwidth is an impressive 10.4Gbits/sec.

The GPU is cooled by a recommended Nvidia heatsink from the reference design, with no heatsinks on the memory. Like the other two Xtacy cards, no overclocking utility is included, but VisionTek hasn't uprated the heatsinks as other manufacturers have.

On the backplate are the standard connectors for the Ti 4600. A DVI connector sits aside the D-SUB and an adaptor included in the box allows the S-Video socket to be used for both input and output. The only item missing is a DVI-to-D-SUB adaptor that would allow a second non-DVI monitor to be used in a dual configuration.

Unfortunately, this flagship card is lacking in the software department. The only addition to CyberLink PowerDVD XP 4 is a copy of CyberLink PowerDirector – a simple video-editing package to complement the video-in capability of the card. Gainward also offers this functionality on its Ti 4600 offering.

Since both other standard Ti 4600 cards in this test include a more comprehensive software bundle for a similar price, there's nothing to recommend the VisionTek above either of these.

PC PRO RESULTS
OVERALL
112
FEATURES	PERFORMANCE	VALUE
105	158	75
100 IS THE AVERAGE