

Matrox MGA Optimization Tools

MGATweak

Version 1.12 Beta Release

Build 015

For Windows 9x

By Liew Khong Jye

September 7, 1999

Disclaimer:

Using this software involves direct reprogramming of Matrox hardware registers to improve 2D/3D graphics and video performance at the expense of forcing the hardware to operate at out-of-specs condition. Improper use of this software will cause irreversible damage to the hardware and render the warranty void. The author will not be responsible for any damage or data loss as a result of using this software.

USE AT YOUR OWN RISK

About MGATweak

MGATweak is my first attempt to produce a unified WIN32 GUI version of Matrox optimization utility. It combines the power of MillCLK, MystCLK and G200CLK, at the same time, fully supports Matrox current cream of the crops — the Matrox MGA-G400 AGP 2D/3D graphics accelerator.

MGATweak supports all Matrox MGA graphics accelerators, range from the old goodies Matrox Millenium PCI (MGA-2064W) to the latest Matrox powerhouse MGA-G400 AGP. MGATweak also introduces a new innovative feature called Clock Monitoring. Clock monitoring enables MGATweak who stays in the background to monitor and maintain the optimized settings previously applied. Clock monitoring effectively serves as a definite solution to various reset-to-factory-defaults problems of DOS-based Matrox optimization utilities, especially with the latest Matrox Powerdesk 5 display drivers.



The complete list of MGATweak supported Matrox MGA graphics accelerators and their respective supporting features is shown as below:

Supported Matrox MGA graphics accelerators	Supporting features
<ul style="list-style-type: none">• MGA-G400 AGP	<ul style="list-style-type: none">✓ System PLL clock speed control.✓ Clock dividers control.✓ Clock source selection control.✓ Clock duty cycle correction control✓ SDRAM/SGRAM optimization.✓ Miscellaneous control.
<ul style="list-style-type: none">• MGA-G200 PCI/AGP• MGA-1064/1164SG	<ul style="list-style-type: none">✓ System PLL clock speed control.✓ Clock dividers control.✓ SDRAM/SGRAM optimization.✓ Miscellaneous control.
<ul style="list-style-type: none">• MGA-G100 PCI/AGP*• MGA-2164W PCI/AGP• MGA-2064W	<ul style="list-style-type: none">✓ System PLL clock speed control.

* Developers' chip specification of MGA-G100 is still unavailable from Matrox Developers' Relation website. When the chip specification is released, MGA-G100 will enjoy better optimization from MGATweak.

Development History

MGATweak is the product of my accumulated experience in programming Matrox hardware. Back to 1997, my first Matrox optimization utility — MystCLK, was released to support Matrox Mystique. My first Matrox card was Matrox Mystique bought from Singapore, with curiosity to try out the product of a prestigious name in PC graphics industry. I was with S3 display cards for a long time. MystCLK turned out to be a successful project, much better than I had expected. I could never imagine that an overclocking utility would receive such a good acceptance from Matrox users community. This had encouraged me to move on with MillCLK for Matrox Millenium/Millenium II and extend MystCLK supports for newer Matrox graphics accelerators. The MystCLK and MillCLK era was the hard time for me, as I was still new in those overclocking stuffs. I had learned many good lessons from trial-and-error which turned out to be a great help when I moved further to produce G200CLK and MGATweak. G200CLK introduced a new technique to directly access Matrox memory-mapped registers in protected-mode linear memory. The new technique proved to be more efficient and much easier to code than that implemented on MystCLK and MillCLK. This technique is also used extensively in MGATweak as all WIN32 executables run in protected-mode. Unlike MystCLK and MillCLK which are written in Intel x86 Assembly Language, G200CLK and MGATweak are written in C/C++ in hope of better portability.

MGATweak is my latest work of Matrox optimization utilities. It provides a major upgrade to all current MystCLK, MillCLK and G200CLK users with user-friendly GUI, new features, enhancement and full support for MGA-G400. I would like to take this opportunity to thank all MGATweak beta testers for their great help. MGATweak will not be perfect without their prompt and comprehensive feedbacks.

MGATweak Version 1.00 Beta Build 000-009

- Internal beta for Mystique/G200/G400 beta testers.
- Support for MGA-1064/1164SG, MGA-G200 PCI/AGP, MGA-G400 AGP.
- Many bugs fixed

MGATweak Version 1.00 Beta Build 010-011

- Internal beta for Millenium/Millenium II/G100 beta testers.
- Added support for MGA-2064W, MGA-2164W PCI/AGP, MGA-G100 PCI/AGP.
- A few more bugs fixed.

MGATweak Version 1.00 Beta Build 012

- Internal beta for all beta testers.
- Features complete.
- New icons.
- Minor cosmetic changes.

MGATweak Version 1.10 Beta Build 013

- Public beta.
- Fixed screen corruption on clock monitoring when system goes in and out of standby.
- Added full documentation.
- Minor cosmetic changes.

MGATweak Version 1.11 Beta Build 014

- Internal Beta.
- Experimenting MGA-G400 clock duty cycle correction.

MGATweak Version 1.12 Beta Build 015

- Added option to enable/disable auto duty cycle correction.
- Added control for clock duty cycle correction.

Using MGATweak



MGA Information Display detected MGA chip, type of RAMDAC, physical address of MGA Control Aperture and mapped linear address of MGA hardware registers.

System PLL Clock Display system PLL clock speed, system PLL's M, N, P, S parameters and derived graphics clock, memory clock and WARP clock. System PLL clock speed is the function of M, N, P. On MGA-2064/2164W, the system PLL is the MCLK PLL in TI TVP3026/30/33 RAMDAC.

MGA-1064/1164SG:

$$F_o = \frac{(N+1)}{(M+1)(P+1)} * 14.31818MHz$$

MGA-G100/G200/G400:

$$F_o = \frac{(N+1)}{(M+1)(P+1)} * 27.00000MHz$$

MGA-2064/2164W:

$$F_o = \frac{(65-N)}{(65-M) * 2^P} * 8 * 14.31838MHz$$

To change system PLL clock speed, overwrite the system PLL clock speed (Fo) with desired clock speed. Upon apply, MGATweak will calculate for the combination of M, N, P which produces the nearest match to the desired clock speed. Floating-point values are accepted. Unavailable items will be grayed out depends on different MGA chips.

Warning: *there is no error checking on the input of system PLL clock speed. You can enter 1MHz, 1000MHz and even "ABCD", then you will see your system crash immediately.*

Clock Dividers & Selection

Display clock dividers and clock source selection. Different clock dividers and clock source selection can be set from the drop-down lists.

**Clock source selection is only available for MGA-G400.*

Minimize To Tray

When checked, MGATweak will minimize to system tray if the upper-right minimize button is pressed.

You must choose "Apply" before this option will take effect.

Clock Monitoring

When checked, MGATweak will perform monitoring on previously applied settings. If any event occurs and resets the settings to factory default, MGATweak will re-apply all settings. If this option is checked, it is recommended that "Minimize To Tray" be checked as well.

You must choose "Apply" before this option will take effect.

Note: Clock monitoring will be disabled when SDRAM/SGRAM optimization settings are changed.

Save Settings

When checked, upon apply the settings will be saved into Windows registry, HKEY_LOCAL_MACHINE\Software\MGATweak. You should only check this when you have found the optimum settings for you system.

To enable MGATweak to automatically apply the optimum settings from registry, you must create a shortcut to MGATweak in Windows StartUp folder. Then click and open the shortcut properties, and choose "Run minimized". Make sure the "Start in" property points to the correct pathname where MGATweak and all the associated DLL and Vxd reside.

Important: MGATweak will only automatically apply the saved optimum settings from Windows registry if it is started as "Run minimized". Otherwise, MGATweak will come up with its normal windows.

SDRAM/SGRAM Optimization

CAS Latency	3	Cycles	Write-only MGATweak internally maintains the most recently applied settings throughout its execution. On first run, these settings are loaded with chip specification defaults.
Minimum RAS-to-RAS Delay	3	Cycles	
Minimum RAS-to-CAS Delay	4	Cycles	
RAS Minimum Active Time	9	Cycles	
Minimum RAS Precharge Delay	4	Cycles	
Minimum Write Recovery Delay	2	Cycles	
Minimum Read to Precharge Delay	Slow		
Minimum Special Mode Register Delay	2	Cycles	
Minimum Block Write Cycle Delay	2	Cycles	Read/Write These settings always show the current state of the hardware.
Minimum Block Write to Precharge Delay	5	Cycles	
Memory Clock Base Read Delay 0	1.6	ns	
Memory Clock Base Read Delay 1	1.6	ns	
Memory Refresh Counter	2497	MCLK period	

SDRAM/SGRAM optimization is a unique feature of all my Matrox optimization utilities, except MillCLK which the hardware itself does not provide any opportunity for optimizing memory timings. Many overclocking utilities do not provide this optimization. While I do admit that SDRAM/SGRAM optimization does not give as much performance boost as increasing system PLL clock speed, there is still slight improvement on fillrate at least.

The Memory Control Wait State (MCTLWTST) register in Matrox chips is a write-only register. Once the settings are written, they cannot be read back. So the only way to identify the validity of SDRAM/SGRAM optimization is to perform a fillrate test. Recommended software is Microsoft D3DTest. This is an old DirectX 3 demo, but provides consistent measures of fillrate. MGATweak internally maintains the most recently applied settings throughout its execution. If MGATweak exits and restarts, the settings will be loaded with chip specification defaults.

IMPORTANT: Chip specification defaults are not as optimum as Matrox Powerdesk defaults. If you choose to activate SDRAM/SGRAM optimization, you must find out the optimum settings for your system. **DO NOT** use chip specification defaults. **Using SDRAM/SGRAM optimization without properly configuring the settings will result in performance loss.**

Memory Clock Base Delay 0/1 and Memory Refresh Counter do not belong to MCTLWTST register. They are from read/write registers. So these settings will always show the current state of the hardware.

MGATweak SDRAM/SGRAM optimization uses true values in MCLK cycles for various memory timings as documented in chip specification rather than the symbolic values used in DOS-based Matrox optimization utilities, MystCLK and G200CLK. To import SDRAM/SGRAM optimization from MystCLK and G200CLK:

MystCLK:

Run MystCLK /2 [...your favourite settings...] and take down the number of MCLK cycles as shown by the output of MystCLK after the settings have been applied. Use these numbers in MGATweak.

G200CLK:

Run G200CLK /2 [...your favourite settings...] and take down the number of cycles and ns as shown by the output of G200CLK after the settings have been applied. Use these numbers in MGATweak.

Step-by-Step: Finding Good SDRAM/SGRAM Optimization (For G400 Users)

This is what will be shown in SDRAM/SGRAM dialogbox on first run. Most settings are loaded with chip specification defaults.

The screenshot shows the SDRAM/SGRAM dialog box with the following settings:

Setting	Value	Unit
CAS Latency	3	Cycles
Minimum RAS-to-RAS Delay	3	Cycles
Minimum RAS-to-CAS Delay	4	Cycles
RAS Minimum Active Time	9	Cycles
Minimum RAS Precharge Delay	4	Cycles
Minimum Write Recovery Delay	2	Cycles
Minimum Read to Precharge Delay	Slow	
Minimum Special Mode Register Delay	2	Cycles
Minimum Block Write Cycle Delay	2	Cycles
Minimum Block Write to Precharge Delay	5	Cycles
Memory Clock Base Read Delay 0	1.6	ns
Memory Clock Base Read Delay 1	1.6	ns
Memory Refresh Counter	2497	MCLK period

Optimization steps overlaid on the dialog box:

- Step 1**: Most system can do with the fastest timings of these settings.(1, Fast, 1, 1, 1). Apply. If no screen corruption proceed to next step.
- Step 2**: Decrement the setting by 1 cycle everytime. Apply. Stop when the screen becomes unstable or the fastest timing achieved.
- Step 3**: Decrement the setting by 1 cycle everytime. Apply. Stop when the screen becomes unstable or the fastest timing achieved.
- Step 4**: Decrement the setting by 1 cycle everytime. Apply. Stop when the screen becomes unstable or the fastest timing achieved.
- Step 5**: Decrement the setting by 1 cycle everytime. Apply. Stop when the screen becomes unstable or the fastest timing achieved.
- Step 6**: Decrement the setting by 1 cycle everytime. Apply. Stop when the screen becomes unstable or the fastest timing achieved.

Step 7 – Decrement Memory Clock Base Read Delay 0 and 1. Both must be decremented by the same value at the same time. Apply. Stop when screen becomes unstable or 0.0 ns achieved.

Setting Memory Refresh Counter to non-default values is important to enable MGATweak clock monitoring to maintain optimum settings for SDRAM/SGRAM optimization. As mentioned before, MCTLWTST register is write-only. So how can MGATweak clock monitoring detect changes in SDRAM/SGRAM optimization settings which may be reset to factory defaults?? The clue is, when SDRAM/SGRAM optimization settings have been reset to factory defaults, Memory Refresh Counter will be reset to default value as well. Hence, it is recommended to set Memory Refresh Counter one step above or below the default value shown for MGATweak clock monitoring to maintain the optimum SDRAM/SGRAM optimization settings.

Several working SDRAM/SGRAM optimization settings:

MGA-G400: 3, 1, 3, 8, 3, 1, Fast, 1, 1, 1, 1.4, 1.4

(Thanks to Darko Vojinovic dvojinov@zg.tel.hr for finding this SDRAM/SGRAM optimization settings for G400 users.)

MGA-G200 SGRAM: 3, 1, 2, 5, 2, 1, Fast, 1, 1, 1, 0, 0
3, 1, 2, 5, 2, 1, Fast, 1, 1, 1, 1.6, 1.6
3, 1, 2, 6, 2, 1, Fast, 1, 1, 1, 0, 0

MGA-G200 SDRAM: Most MGA-G200 SDRAM are capable of full SGRAM/SDRAM optimization. Just use the fastest timings for every setting.

2, 1, 2, 3, 2, 1, Fast, 1, 1, 1, 0, 0

If this one does not work, pick from MGA-G200 SGRAM sets.

MGA-1064/1164SG: 3, 2, 4

Miscellaneous Control



* Certain miscellaneous control options may not be available depends on different MGA chips. Unavailable options will be grayed out.

- | | |
|------------------------------------|--|
| PCI Retry | Enable retry sequence to be generated on PCI bus. This option is also available from Matrox Powerdesk drivers.
Enable for better performance.
Disable if experience sound glitches from ISA soundcard or serial ports overrun. |
| Hardware Plane Write Mask | Enable to make use of special SGRAM features. This option SHOULD NOT be enabled with SDRAM-equipped MGA boards. |
| Enhanced PCI Master Read | Enable the use of advanced PCI read command (MRL & MRM) by PCI master. May not be relevant for AGP-based MGA boards. |
| MFIFO High Priority Request | Enable high priority request from MFIFO. |

Duty Cycle Correction

MGATweak Version 1.12 Beta Build 015 has added control for MGA-G400 clock duty cycle correction. According to the chip specification, MGA-G400 has built-in duty cycle correction circuitry to maintain 45/55 duty cycle on graphics clock, memory clock and WARP clock. Duty cycle correction is only needed when clock divider is 1.5 or 2.25. Duty cycle correction for graphics clock, memory clock and WARP clock can be programmed independently. The value of duty cycle correction is the function of the respective clock in period (ns). MGA-G400 chip specification includes a reference table for duty cycle correction.

Since I do not have a G400 to test the MGA-G400 portion of code in MGATweak, I wrote the G400 code in MGATweak EXACTLY based on all the recommendations of chip specification. That is, the value of duty cycle correction will be programmed automatically by MGATweak based on the duty cycle correction reference table without user intervention. When everything follows exactly as stated in the chip specification, the maximum system PLL clock speed that can be used seems to be 310MHz, using the default clock dividers. Whether it is pure coincidence or Matrox purposely designed MGA-G400 in such a way, the maximum system PLL clock speed stated in the chip specification is also 310MHz. This implies that all MAX version of MGA-G400 are actually operating at near limit of the hardware if we assume that G400 MAX is just an overclocked G400. This also turns out that MGATweak does not serve well in overclocking G400 MAX using default clock dividers.

Thanks to Raymond Bakker raymond.bakker@inter.ni.com (aka Scytale) from MURC Matrox Hardware forum who brought up the issue of overclockability using MGATweak and Entech Powerstrip. Powerstrip is able to overclocked G400 MAX at a much higher system PLL clock speed than MGATweak. It was later verified that Powerstrip indeed ignores the duty cycle correction in programming system PLL.

MGATweak Version 1.12 Beta Build 015 now comes with the option to enable or disable auto duty cycle correction, and allow the G400 MAX users to overclock at a much higher system PLL clock speed using default dividers. The default behaviour of MGATweak is auto duty cycle correction enabled to follow chip specification recommended programming procedures. When auto duty cycle correction is disabled, the user can enter preferred duty cycle correction values for each clock, or simply ignore duty cycle correction and use the current state of the hardware. The later violates chip specification recommendation, but proved to be able to overclock G400 MAX very well.

For vanilla G400 users who only opt to overclocked at MAX speed, auto duty cycle correction should be left enabled. If you want to push over MAX speed, auto duty cycle correction must be disabled. So do G400 MAX users. For those extreme tweakers who would like to tune the duty cycle correction, here is the reference that you should refer to.

**Factory default Matrox Millenium G400 MAX
(PLL = 301.5MHz, GCLK = 150.75MHz, MCLK = 201.00MHz, WCLK = 150.75MHz)**

Duty cycle correction (GCLK / MCLK / WCLK) = 0 / 11 / 0.

Duty cycle correction

0	Duty cycle unaffected
1-15	Lower values for higher speed. (chip specification)

User Feedback

MGATweak is still very much in its infancy. User feedbacks are highly encouraged to improve the robustness and stability of MGATweak and ensure wide compatibility with various combinations of hardware and software. If you come across any difficulties using MGATweak, you should acknowledge me of the problem, and I will try to make MGATweak work with your system. Please refer to BETANOTE.TXT on what information you should send in as feedback.

Feel free to write to me anything about MGATweak, its goods and bads. If you need my help to port MGATweak to other OS such as Windows NT or Linux, your initiative is greatly welcome.

About The Author

I am an undergraduate from University of Technology Malaysia (UTM), major in Computer Engineering. A casual programmer and a hobbyist hacker, too. I will be graduating from the university for my first degree by December 1999. I can be reached by the following means:

Mailing Address: Mr. Liew Khong Jye
14, Jalan Mas,
11600 Penang,
Malaysia.

Tel: (604) 6571689 / 6584203

E-mail Address: kjliew@pop.jaring.my
kjliew@matroxusers.com

ICQ UIN: 3185960

MGATweak is totally FREE. However, I do appreciate contribution in the form of computer hardware peripherals and databook/datasheet to expand my support for other products.

If you like my software and appreciate my work, it would be most lovely if you can send me a postcard showing the beauty of your country.

MGATweak Distribution Sites

Matrox MGA Optimization Tools, <http://mgatools.matroxusers.com/>
Matrox Users Resource Centre, <http://www.matroxusers.com/>

Public beta releases of MGATweak can be freely redistributed as long as it is distributed in its original package. MGATweak SHOULD NOT be included as part of bundle of any commercial products without the author's prior consent.

Acknowledgement

Special thanks to:-

- Anthony Pitt
- Tideman Stefan
- Royce Liao
- Matrox Graphics Inc.
- All beta testers who have participated in beta testing my Matrox optimization utilities.