

CardTrickEVD

Niels Knoop

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Chapter 1

CardTrickEVD

1.1 CardTrickEVD

CardTrickEVD 1.0

ShapeShifter External Video Driver
for CyberGraphX & Picasso96
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1.2 CardTrickEVD

Introduction

CardTrickEVD, as its name suggests, is a ShapeShifter driver for graphics cards. It is meant to be an universal driver for nearly all cards, color depths, pixel formats and refresh types.

But why use an external driver when ShapeShifter already comes with built-in support for CyberGraphX and Picasso96? Well, as its name also suggests, CardTrickEVD is full of tricks and thus offers a number of new abilities.

Details are listed in the feature list. Considering that CardTrickEVD basically supports, enhances or improves everything the internal driver can do, the decision should be an easy one.

1.3 CardTrickEVD

Features

- Support for most Amiga graphics cards
- Mac displays with 1, 2, 4, 8, 15, or 24 bits per pixel
- Fast refresh routines for all pixelformats
- Delta-buffering
- MMU-refresh
- Locking during refreshes
- Screens without memory buffers
- Direct displays without refresh
- Remapping of direct displays
- Blitter acceleration support
- Special RGBA truecolor displays
- Switchable AutoScroll

1.4 CardTrickEVD Features

Graphics cards

CardTrickEVD uses the CyberGraphX API and, if available, some additional features of Picasso96, but no undocumented things. Thus it should work with all Amiga graphics cards running a CyberGraphX-compatible driver.

If the driver you are using isn't CyberGraphX-compatible you should look for a replacement. CyberGraphX itself and compatible driver systems like Picasso96 support a wide range of Amiga graphics cards including rather old ones.

Certain very old cards like the A2410 don't allow direct access to their video memory. Even though refreshed CardTrickEVD displays might still work with them, the resulting performance will probably be discouraging because the driver has to do an additional refresh procedure itself. In such cases specific EVDs for these cards can do a much better job.

1.5 CardTrickEVD Features

Display modes

CardTrickEVD supports all Mac display modes you can use with ShapeShifter: 1, 2, 4, 8, 15 and 24 bit per pixel. This means in first place that if you want Mac displays with 2, 4 or 16 colors for compatibility or other reasons, you can now use them on your graphics card, too.

1.6 CardTrickEVD Features

Refresh routines

Amiga graphics cards use a large number of different pixelformats for their screens in high- and truecolor. CardTrickEVD provides fast refresh routines for all pixelformats known by CyberGraphX, so you are free to select any 15- or 16-bit screenmode for highcolor and any 24- or 32-bit screenmode for truecolor displays. For ShapeShifter displays with 2 to 256 colors CardTrickEVD uses the 8-bit chunky-pixel screenmodes all graphics cards support.

1.7 CardTrickEVD Features

Delta-buffering

Refresh involves keeping a display buffer for ShapeShifter in Fast-RAM and periodically updating its contents into the Amiga screen and thus into the video memory of the graphics card. This costs a considerable performance penalty especially because the bus between CPU and graphics card, even if it is Zorro-III, usually forms a bottleneck.

To reduce the refresh overhead CardTrickEVD offers delta-buffering. This technique needs a second refresh buffer in Fast-RAM and thus consumes more memory, but reduces the bus load by updating only those parts of the display which really have changed.

The benefit depends on the ratio between memory and bus speed of the Amiga. For example, an A2000 user with a fast accelerator card and a Zorro-II graphics card will experience a much higher speed increase than an A4000 owner with slow A3640 and fast Zorro-III graphics card.

1.8 CardTrickEVD Features

MMU-refresh

MMU-refresh means to use the MMU to watch over the refresh buffer and keep track of which parts of it are written to by the emulated Mac. The goal to keep untouched parts of the display out of the refresh procedure is the same as with delta-buffering.

The advantage of doing it with the MMU is that it needs no extra buffer in Fast-RAM and only negligible amounts of time. This enables the emulation to run at almost full speed as long as nothing much happens on the display. On the other hand, the MMU records the changes only in rather coarse memory blocks called MMU pages. It may thus select large partitions of the display buffer to be refreshed although only a few pixels were really affected.

Generally speaking MMU-refresh is more powerful than delta-buffering, but for best results both techniques can be combined.

CardTrickEVD's MMU routines require a 68040 or 68060 CPU and support both

4K and 8K pagesize. The MMU tables must already be set up and enabled which is usually done by the 68040.library at the time SetPatch is executed.

1.9 CardTrickEVD Features

Locking during refreshes

If ShapeShifter's screen is flipped to back while being refreshed another screen possibly taking its place in the video memory will be overwritten. CardTrickEVD avoids this by locking the screen bitmap during refreshes.

Of course it is highly recommended to always press Ctrl-Tab in ShapeShifter before switching to another screen, but it's still nice that nothing will go wrong if you forget it or if some program or requester brings its screen to front itself.

1.10 CardTrickEVD Features

Screens without memory buffers

Usually all graphics card screens have a buffer in memory to store their data if they need to be swapped out of the actual video memory to make room for other screens. This is not necessary with refreshed displays because their contents is derived and can be restored from the Mac display buffer at any time.

Picasso96 offers a special kind of screen without backup memory for such purposes. CardTrickEVD uses it for all refreshed displays and thus can save a considerable amount of memory.

1.11 CardTrickEVD Features

Direct displays

In terms of visual appearance and emulation speed, the best refresh method is no refresh at all, meaning that the emulated Mac directly writes into the Amiga screen. This requires the graphics card to support the pixel format the Mac uses. Directly Mac-compatible formats are LUT8 for 8-bit, RGB15 for 15-bit and ARGB32 for 24-bit Mac displays. With a trick RGBA32 works, too.

CardTrickEVD offers you to use direct displays on all suitable screenmodes. This does not gain speed compared with the internal driver, but makes it possible to run all kinds of displays using a single driver and allows to use direct displays with safe access.

A most desirable feature of direct displays is the blitter acceleration.

1.12 CardTrickEVD Features

Remapping of direct displays

Unarbitrated access of the video memory as done by ShapeShifter in direct display modes is a very tricky thing. If the screen is swapped out of the video memory after starting the emulation, the emulated Mac will continue to use the old address and thus corrupt both its own screen and whatever took its place in the video memory. In the worst case the Mac display can be lost forever because the screen is later moved back into the video memory at a different address.

CardTrickEVD's solution to this problem is to remap the Mac display with the MMU whenever the screen changes its address. Doing so ensures that writes to the Mac display memory always hit the right spot and never trash other screens. This feature requires Picasso96 and a working 040/060 MMU.

1.13 CardTrickEVD Features

Blitter acceleration support

Starting with version 3.6, ShapeShifter provides blitter acceleration support on direct CyberGraphX/Picasso96 displays. This means that certain graphical operations are performed by the graphics card blitter instead of the CPU which can speed up some things like scrolling dramatically.

Unfortunately this acceleration feature is not made available to external drivers by the current EVD interface. To make it work anyhow, CardTrickEVD has to play some tricks on ShapeShifter. To be precise, it applies a few run-time patches to ShapeShifter's code to activate the acceleration.

One drawback of this trick is that it is version-specific. CardTrickEVD 1.0 supports the release versions 3.6, 3.7 and 3.8 of ShapeShifter (others will work too, but not be accelerated). I hope that future ShapeShifter versions will extend the EVD interface and thus render such stunts superfluous.

1.14 CardTrickEVD Features

Direct RGBA32 displays

The RGBA32 pixelformat (24 bit truecolor & 8 bit alpha channel) as used on the Piccolo-SD64 has a great similarity to the Mac's format ARGB. In fact it is just shifted one byte to the left if you disregard the unused alpha channel byte.

This observation has led to the following trick which was first implemented in `RGBAevd`: Shift the complete Mac display one byte to the left relative to the screen so that the bytes containing the color values for red, green and blue match those of the screen. To avoid trashing the byte in front of the actual screen enlarge the latter by one line on top. The following figure should give an idea:

```
Mac-Display:      [aRGBaRGBaRGB....aRGB]
RGBA screen: [RGBa...|RGBaRGBaRGBa....RGBa]
```

This trick works because the M68020 and later processors of the M68000 family (which are required to run ShapeShifter anyhow) support word and longword operations on odd addresses. However such misaligned accesses cost a significant performance penalty. In effect this method trades in display memory bandwidth for direct access.

CardTrickeVD supports this kind of direct RGBA display. Even ShapeShifter's acceleration routines are activated on it which speeds up scrolling a big deal and also helps to avoid graphical artifacts which sometimes occur because some Mac routines do not expect the display address to be uneven.

1.15 CardTrickeVD Features

Switchable AutoScroll

CardTrickeVD optionally deactivates the automatic AutoScroll on oversized displays. This little feature is meant for Mac games. Many of them allow to reduce the actual game display size to speed up the gameplay, but cannot change the resolution of the entire Mac display. To play such shrunk games in full-screen rather than stamp size, ShapeShifter users can easily resort to virtual screens like 640x480 on a 320x240 screenmode. Once adjusted to the right position, the visible part of the screen should remain fixed and especially not jump around everytime the mouse pointer is moved out of it unintentionally.

1.16 CardTrickeVD

Requirements

In order to run CardTrickeVD you need:

- An Amiga with a graphics card
- ShapeShifter 3.1 or later
- CyberGraphX 2.10 or later or a compatible driver system

Optional, but highly recommended:

- A 68040 or 68060 processor with MMU for MMU-refresh
- ShapeShifter 3.6, 3.7 or 3.8 for blitter acceleration
- Picasso96 1.27 or later for direct display remapping

1.17 CardTrickeVD

Installation

Simply copy CardTrickeVD into the "Video Drivers" drawer inside your

ShapeShifter drawer.

1.18 CardTrickEVD

Configuration

Start ShapeShifter and go to the Graphics Settings window. Set Screen type to External and select CardTrickEVD as External driver.

Choose the Color depth you want to use and then select an appropriate Screen mode for it:

Mac Color Depth	Amiga RTG Screenmode
1, 2, 4 or 8 bit	8 bit Chunky-Pixel
15 bit	15 or 16 bit Highcolor
24 bit	24 or 32 bit Truecolor

The display dimensions will automatically adjust to the screen. If you want a different size you can enter your own values next to Size. Oversized displays will enable AutoScroll. Using a display which is smaller than the screen is possible, but not recommended. I suggest to create a screenmode with the desired dimensions instead.

Selecting a Refresh rate value basically means to find the best compromise between display update speed and emulation performance. Lower values will improve the visual impression, but leave less power for the emulated Mac. When using MMU-refresh, only graphical operations cause slowdowns, making it possible to use the minimum refresh rate of 1. The refresh rate has no meaning if you use direct displays.

You can decide to use the Amiga mouse pointer instead of ShapeShifter's own software cursor to improve the visual appearance of the mouse pointer in slow refresh modes. This is also recommended when using AutoScroll screens because the visible part of the screen follows the Amiga pointer. However the Amiga pointer sprite will not reflect the real Mac pointer images.

The state of the check box Black border is not passed on to the EVD and therefore has no effect with it. The same is true for Refresh always and MMU refresh. The actual refresh mode will be selected later when the emulation is started.

In ShapeShifter's Memory Settings, it's usually not a good idea to select the Largest free block option, because it might leave only slower memory or none at all for CardTrickEVD's refresh buffers. You should disable it and enter a reduced Mac memory value instead.

If you often use different settings for different EVDs and screenmodes, I suggest to save them into individual projects using Save As... from the main menu.

For more information about ShapeShifter's settings please refer to the ShapeShifter manual.

1.19 CardTrickEVD

Usage

After selecting CardTrickEVD as external driver in ShapeShifter's settings, CardTrickEVD is automatically run when you start the emulation. What remains to be done is the selection of the actual refresh mode, either by hand or automatically.

By default CardTrickEVD will present a requester asking to choose a refresh mode. Depending on your system, graphics card and selected screenmode you can choose between some or all of the following (in order of performance):

Direct

Direct display without refresh.

MMU&Delta

Refreshed display, accelerated by the MMU and delta-buffering.

MMU

Refreshed display, accelerated by the MMU.

Delta

Refreshed display, accelerated by delta-buffering.

Simple

Plain refreshed display.

Abort

Quit the emulation if you changed your mind.

For those who don't want to do this selection every time and probably run ShapeShifter with the QUICKSTART tooltype set, there is a possibility to let CardTrickEVD select the best refresh mode automatically and thus avoid the requester. This feature is enabled and controlled by a set of options.

Even if automatic selection is activated, you can still force CardTrickEVD to open its requester by turning on capslock or holding down either shift key while starting the emulation.

1.20 CardTrickEVD

Options

CardTrickEVD provides a number of options to control some of its features. Their settings are stored as an argument string in the environment variable ENV:CardTrickEVD.config. If you want to enable certain options (most of them work as switches and are disabled by default), write or edit that file and enter all the options you want in a single line separated with spaces.

For example, to set some options from an Amiga shell window you could type:

```
Echo >ENV:CardTrickEVD.config "AUTOSELECT NOAUTOSCROLL BLOCKSIZE=64"
```

To make your changes permanent, also copy the file over to ENVARC:..

The options are:

```
AUTOSELECT
NODIRECT
NORGBA
NOMMU
NODELTA
NOEMAP
NOAUTOSCROLL
BLOCKSIZE
```

1.21 CardTrickEVD Options

AUTOSELECT

By default, CardTrickEVD always pops up a requester to let you choose the refresh mode you want. This requires just one additional mouse click and has the advantage that you always know what's going on. However, if you don't like to get the requester every time, probably because you don't change your settings very often and use ShapeShifter's QUICKSTART tooltype, you might want to use the AUTOSELECT option.

In this mode, CardTrickEVD will automatically select the best refresh mode according to what the actual ShapeShifter settings, system resources and CardTrickEVD options permit. By default it will use a direct display whenever the chosen screen's pixelformat allows it. Refreshed displays will be accelerated by the MMU if an enabled 040 or 060 MMU is found and by deltabuffering if there is enough memory available.

If you have AUTOSELECT enabled, but still want to make a different choice now and then, you can force the requester to open by holding down either shift key or having capslock enabled while starting the emulation.

1.22 CardTrickEVD Options

NODIRECT

CardTrickEVD's automatic refresh mode selection will use a direct display whenever possible. If you prefer a refreshed display you can enforce it by using the NODIRECT option, which is CardTrickEVD's equivalent to the Refresh always checkbox in the ShapeShifter settings.

Usually even the fastest refresh works slower and doesn't look as smooth as a direct display, but is safer if you can't use display remapping. It may also be interesting on systems with very slow graphics card and very fast memory.

1.23 CardTrickEVD Options

NORGBA

Using a direct Mac 24 bit display on a RGBA32 screen requires shifting the display address to an odd address which can confuse certain Mac routines and thus cause artefacts on the screen. Setting the NORGBA option will cause the automatic refresh mode selection to use a refreshed display instead. Other, truly Mac-compatible pixelformats can still be used for direct displays.

1.24 CardTrickEVD Options

NOMMU

If this option is activated, the automatic refresh mode selection will not use the MMU to reduce the refresh overhead. This is meant for test purposes only; it should never be necessary to enable it unless you have problems with your MMU.

1.25 CardTrickEVD Options

NODELTA

Activating this option will tell CardTrickEVD not to select a refresh mode with delta-buffering. This means that the driver will perform simple refresh and not allocate a second refresh buffer. Use this option if you find that the speedup accomplished by delta-buffering is not worth the additional memory on your system. Even if this option is not enabled, CardTrickEVD will automatically disable delta-buffering if there is not enough memory for it.

1.26 CardTrickEVD Options

NOREMAP

One of CardTrickEVD's main features is the remapping of direct displays with the MMU to prevent the emulation from trashing other screens if the screen address changes. Usually this is what you want. However, should you encounter problems with this feature, possibly because of a defective MMU or a conflict with other software using it, you can disable it with the option NOREMAP.

1.27 CardTrickEVD Options

NOAUTOSCROLL

This option disables AutoScroll on oversized displays. Adjusting the screen position is still possible by dragging the screen with the mouse

while holding down the screen drag qualifier(s) selected in the IControl preferences program (usually the left Amiga key).

1.28 CardTrickEVD Options

BLOCKSIZE

To avoid trashing other screens CardTrickEVD locks its screen during the refresh using a function of the graphics board driver system. Unfortunately this lock can temporarily block other system functions as well, which might result in a jerkily moving Amiga mouse pointer and other unpleasant effects if the lock is kept for a long period of time. For this reason CardTrickEVD splits each refresh cycle into a number of blocks and releases the lock in between. Naturally this method causes some overhead.

The option `BLOCKSIZE=<n>` allows you to tune the refresh performance by setting the amount of display data refreshed in one part to `n` Kbytes. The default size is 8K which should guarantee smooth operation even on slow systems. Users with fast systems might want to experiment with higher block sizes to get more speed. This option has no meaning with direct displays.

1.29 CardTrickEVD

Questions & Answers

- Q: If I use the Amiga mouse pointer for ShapeShifter in 8 bit, it is colored strangely. Why?
- A: The Amiga doesn't have separate color registers for sprites, but uses certain entries of the view's palette. Although graphics cards don't share this limitation, they inherit it through their RTG driver for compatibility reasons. This is no problem as long as screenmodes use only the first part of the palette (1 to 4 bit) or no palette at all (15 to 32 bit), but everytime the emulation loads the complete palette of 256 colors in 8 bit, the hardware cursor colors are overwritten along with it.
- Q: In some modes the Amiga mouse pointer flickers or leaves garbage on the display. What is going on?
- A: These effects reveal that the Amiga mouse pointer is actually a software cursor. Such cursors are drawn by the graphics card driver software and have to be blanked while the screen is being refreshed. As a result the pointer will flicker. If you use a direct display with such a cursor, display and mouse updates will collide and cause trash on the screen. If your graphics card supports it and your driver software gives you a choice, always use the hardware cursor wherever possible. Otherwise you should use ShapeShifter's own software cursor instead which doesn't suffer from these problems and also displays the correct images.
- Q: The Amiga mouse pointer moves rather jerkily on refreshed displays. Why?
- A: For safety reasons CardTrickEVD locks the screen while refreshing it. Depending on the way the graphics card driver software implements the
-

locking it can block other system activities and thus prevent the mouse pointer position from being updated. To avoid this problem, CardTrickEVD does not lock the screen for a complete refresh cycle but on intervals instead. If you experience a jumping Amiga mouse pointer, try a lower block size for the refresh.

1.30 CardTrickEVD

Warnings and Errors

CardTrickEVD does a lot of safety checks in various fields and usually pops up a requester with a warning or error message if anything goes wrong. You don't need to bother about this until you actually get such a message and don't know what to make of it. Then you can look it up in the following alphabetically ordered tables to get more information about it.

Warnings:

- Not enough Fast-RAM for delta buffer
- Refresh buffer in Chip-RAM

Errors:

- Could not lock display
- Could not open cybergraphics.library V40.60
- Could not open dos.library V37
- Could not open graphics.library V39
- Could not open screen
- Display too large
- Mandatory output tag missing
- Minimum display size 320x200
- Monochrome display width must be multiple of 32
- Not a CyberGraphX/Picasso96 screenmode
- Not enough memory left for refresh buffer
- Screen and buffer row offset do not match
- Screenmode and color depth do not fit
- Unknown pixelformat
- Your Amiga isn't DIN-compatible

1.31 CardTrickEVD Warnings

Not enough Fast-RAM for delta buffer

CardTrickEVD usually tries to allocate a delta buffer to speed up refreshed displays. To be of real use this buffer needs to be in fast memory. If there isn't enough Fast-RAM left for it, CardTrickEVD will display this warning. You can choose to continue anyhow (without delta-buffering) or abort in order to free some memory or reduce the Mac memory setting.

1.32 CardTrickEVD Warnings

Refresh buffer in Chip-RAM

Refreshed displays need a display buffer in memory. If there is not enough Fast-RAM left this buffer will be forced into the slow Chip-RAM which will hurt the performance. If you accept or even want this (because you want to have as much memory as possible for the emulation) you can continue anyhow (in this case CardTrickEVD will also not attempt to use delta-buffering), but probably you will prefer to abort and try again after lowering the Mac memory setting or freeing some RAM by closing other applications.

1.33 CardTrickEVD Errors

Could not lock display

An attempt to lock the newly opened screen and get some information about it failed. This should never occur under normal circumstances.

1.34 CardTrickEVD Errors

Could not open cybergraphics.library V40.60

Running CardTrickEVD requires cybergraphics.library version 40.60 or later (CyberGraphX 2.10). Compatible driver systems should provide a replacement with equal or higher version and revision number. This doesn't necessarily mean that a file of this name must exist in your LIBS: directory. Never mix different driver systems!

1.35 CardTrickEVD Errors

Could not open dos.library V37

CardTrickEVD needs at least V37 of the dos.library. This should not be an issue because ShapeShifter needs OS 2.1 (V38) anyhow.

1.36 CardTrickEVD Errors

Could not open graphics.library V39

CardTrickEVD needs at least V39 of the graphics.library. This is usually no restriction because CyberGraphX & Co. require OS 3.0 (V39) anyhow.

1.37 CardTrickEVD Errors

Could not open screen

If opening the screen fails it is most likely due to lack of memory. If you often get this error you should reduce the amount of memory assigned to the emulated Mac in ShapeShifter's Memory settings.

1.38 CardTrickEVD Errors

Display too large

For technical reasons CardTrickEVD needs to impose an upper limit to the display size. I have set it to 16 MB and guess that this should be enough for now.

1.39 CardTrickEVD Errors

Mandatory output tag missing

This is another internal error which should never occur. If ShapeShifter fails to ask for vital data CardTrickEVD aborts rather than letting it guess.

1.40 CardTrickEVD Errors

Minimum display size 320x200

To avoid trouble if the user accidentally sets too small display dimensions, CardTrickEVD checks for a minimum display size of 320x200 pixels.

1.41 CardTrickEVD Errors

Monochrome display width must be multiple of 32

CardTrickEVD requires the display line width to be a multiple of longwords or 32 bits. Usually this is the case because ShapeShifter automatically rounds up the display width to multiples of 16. However in the rare case of a monochrome (1 bit) ShapeShifter display with an uneven multiple of 16 as width CardTrickEVD will issue this complaint. Simply adjust your display size then.

1.42 CardTrickEVD Errors

Not a CyberGraphX/Picasso96 screenmode

This message means that you have accidentally selected a native Amiga screenmode or that the driver software providing the selected mode is not CyberGraphX-compatible.

1.43 CardTrickEVD Errors

Not enough memory left for refresh buffer

ShapeShifter allocates its own memory for the emulation, ROM etc. before calling CardTrickEVD. For this reason CardTrickEVD might not find enough RAM left to allocate a display buffer for a refreshed display. If this happens, you should disable the Largest free block option and lower the Mac memory value in ShapeShifter's Memory settings.

1.44 CardTrickEVD Errors

Screen and buffer row offset do not match

Remapping a direct CardTrickEVD display with the MMU requires the screen and its backup buffer in memory to have exactly the same dimensions, especially the same row offset in bytes. This might not be the case if you use a display width smaller than the screen width. If you get this error, try to set the display width to (at least) the width of the screen.

1.45 CardTrickEVD Errors

Screenmode and color depth do not fit

Although CardTrickEVD supports all color depths and screenmodes, not all combinations make sense. Correct configurations are 1/2/4/8 bit depth on 8 bit screens, 15 bit depth on 15/16 bit screens and 24 bit depth on 24/32 bit screens.

1.46 CardTrickEVD Errors

Unknown pixelformat

CardTrickEVD supports all pixelformats known by CyberGraphX today, but it is possible that new cards and drivers add new ones in the future.

1.47 CardTrickEVD Errors

Your Amiga isn't DIN-compatible

Didn't I tell you that it's no use browsing through the list of errors unless you are looking for one which actually occurred? I guarantee that you'll never see this one. ;-)

1.48 CardTrickEVD

Bugs

"Crashing tells the user nothing. It is uncouth and barbarian and entirely in line with the (overly) stereotypical German mindset."
- Joanne Dow in comp.sys.amiga.programmer

Well, of course I hope that CardTrickEVD will not crash your machine. :-)
If anything goes wrong, CardTrickEVD will always try to tell you the reason. But although I tried my best to avoid dangers and hunt down bugs, it is not impossible that some are still lurking somewhere.

So if you encounter barbarian crashes or other uncouth behaviour of CardTrickEVD, please let me know.

1.49 CardTrickEVD

Copyright

CardTrickEVD is Mailware. If you like and use it, please send me some mail of any kind. A few lines of e-mail will do, but I would prefer paperware, i.e. nice postcards, letters, parcels... :-)

Program and documentation are freely distributable as long as the archive remains complete and unchanged.

This software is provided "as is" without warranty of any kind, either expressed or implied. You use it entirely at your own risk.

1.50 CardTrickEVD

Credits

I would like to thank the following people:

- Francesco Doro for encouragement, advice, beta-testing and the acceleration activation trick
 - Oliver Blumert for beta-testing
 - Christian Bauer for ShapeShifter and its EVD interface
 - Frank Mariak & Thomas Sontowski for CyberGraphX
-

- Tobias Abt & Alexander Kneer for Picasso96
- Frank Wille for PhxAss and PhxLnk

1.51 CardTrickEVD

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