

# CarDiCon ©

**Version 1.34\***

\* Note: Some functions added in v.1.342B are not documented yet

" DICOM 3 STD-XABC-CD" => AVI Converter  
( "Basic Cardiac X-Ray Angiographic Studies on CD-Media" )

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# 1. Features, Hard- and Software Requirements

## 1.1. Overview

### CarDiCon (C)

#### DICOM viewer functions\*\*

- single frame mode
- adjustable framerate
- grayscale enhancement
- magnification
- video edit
- DICOM file (study) information

- **Editierfunktionen:**

- adjustable framerate
- grayscale enhancement
- single frame mode
- select part of an image sequence (e.g. to remove images without contrast agent)
- select image segments for DICOM => AVI conversion

#### Convert the edited sequence to an AVI file

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\*\* (for STD-XABC-CD ["Basic Cardiac X-Ray Angiographic Studies on CD-R Media] DICOM 3 files)

OTHER DICOM FORMATS ARE NOT SUPPORTED

## 1.2. Target Group

### Target Group

- Everyone who needs a viewer for DICOM STD-XABC-CD ("Basic Cardiac X-Ray Angiographic Studies on CD-R Media") files

Everyone who would like to convert those DICOM files (or segments, enhanced segments) to AVI files

## 1.3. System Requirements

### System requirements

- Pentium processor (or similar) > 200 MHz \*\*
- Operating system Microsoft Windows 95/98 or Windows NT
- Video card and monitor: resolution  $\geq 600 \times 800$  pixels, 24 or 32 bits color
- >32MB RAM (Windows 95/98), >64MB RAM (Windows NT)
- CD-ROM drive, preferably faster than 2x
- Mouse or equivalent input device

\*\* This is not an absolute requirement, but necessary for real-time cine display at 12 frames/sec. The software will work on slower processors, but the cine will not be shown in real-time. Even slow processors can convert the sequences to DICOM -- AND MOST SLOW PROCESSORS WILL EVEN BE ABLE TO PLAY BACK THOSE AVI FILES IN REAL-TIME.

## 1.4. System Recommendations

### System Recommendations

- Pentium processor > 300 MHz (or equivalent)
  - 32 bit, true color video card
  - $\geq 64$ MB RAM (Microsoft Windows 95/98),  $\geq 128$ MB RAM when running Windows NT
- CD-ROM, speed 8x or better

## 1.5. Copyright

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<http://www.fhs-consulting.com/cardicon>

This software is based in part on the work of the Independent JPEG Group.

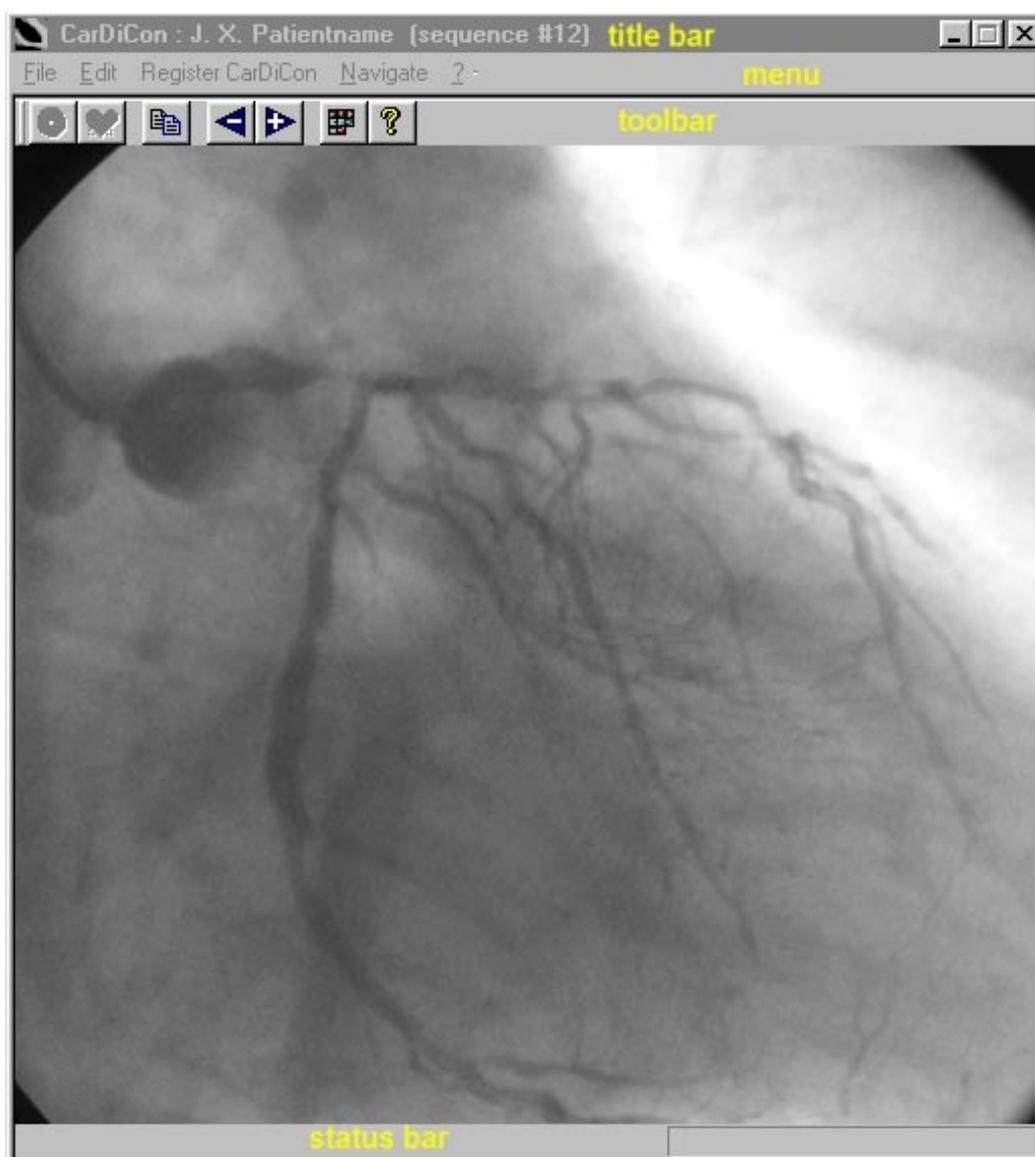
## 2. Running CarDiCon

### 2.1. Main Program Window

CarDiCon's user interface resembles most standard Windows programs: if a CD has been loaded you will find the patient's name and the number of the sequence on CarDiCon's **title**. The next line is called the **menu**, the line below the menu is the **toolbar**.

To load a directory from a CD you can either use the menu command "Edit/DICOMDIR" or simply click the toolbar symbol . The toolbar symbol  will start the "Video edit" dialog, which can also be activated by using the menu entry "Edit/Video edit".

If a command cannot be activated you will find its menu entry and toolbar symbol grayed out, and it will not respond to mouse clicks (for example: the "Video edit" function will only be available after image data have been loaded).



Additional helpful information is displayed on the status bar, such as the progress made during a load or save operation (the area on the right-hand side of the status bar is reserved to show progress information, see [Load](#)

[CD](#)).

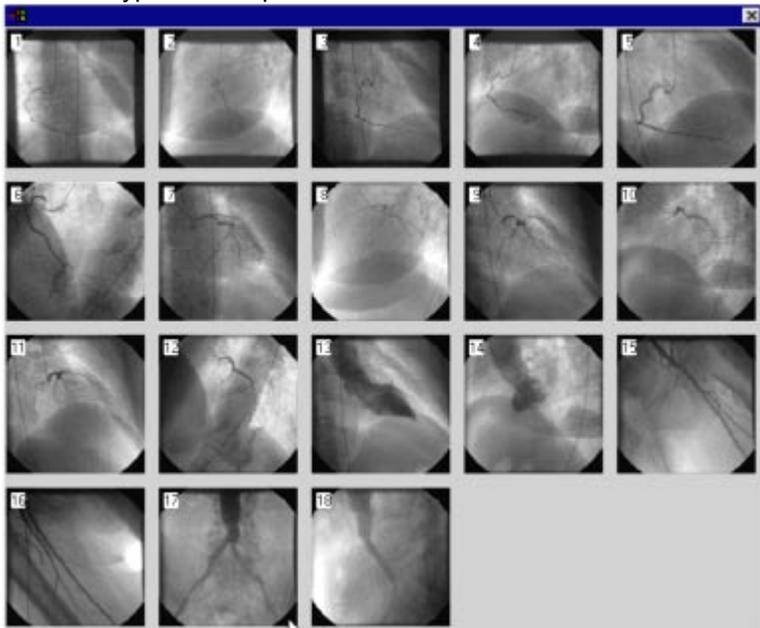
You will also encounter pop-up windows and dialog windows.

## 2.2. Load CD

CarDiCon will search your computer for a CD drive with a DICOM CD. If CarDiCon finds more than one CD a dialog window is going to open and you will be asked to remove all CDs but the one you want to load.

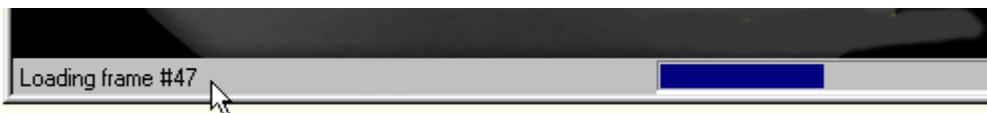
CarDiCon analyzes the DICOMDIR (the CD's directory with just one study; each study consists of at least one sequence) and displays one characteristic image for each sequence. The sequences are numbered and each sequence number is displayed in the left upper corner of the image.

Here is a typical example:



Simply double click the image that represents the sequence you want to view. In case you would like to terminate the selection click on the "close" symbol at the right upper corner of the selection box.

CarDiCon will load the selected sequence. This process may take a moment. While images are being loaded the progress bar moves to the right and a message is shown on the status bar.



Each image is immediately shown in CarDiCon's main window. Many computers are fast enough to give the impression that you are looking at a video while the frames are loaded one by one. The CD drive's speed is the main determinant how quickly the frames are loaded, the processor and hard disk speed are additional factors. The "video edit" dialog box appears as soon as all images are loaded; the progress bar disappears and you can start the editing process.

CarDiCon may have to limit the length of the sequence kept in RAM. If there is insufficient RAM, a dialog box will be shown.

### Important

**Do not open the CD drive's door while images are being loaded.**

**It is safe to open the drive door (and to insert another DICOM CD) as soon as the "Video edit" dialog box is displayed.**

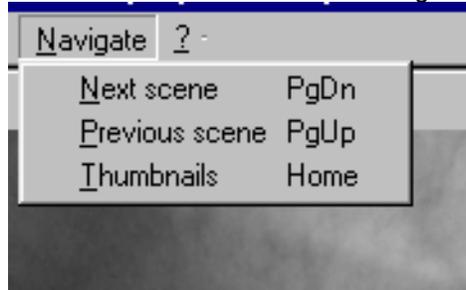
## 2.3. Navigation

Three toolbar symbols facilitate sequence-to-sequence navigation. These symbols are active (active:



) when they are not greyed (greyed: ). Clicking the left symbol (arrow pointing to the left, "-") will load the previous sequence, clicking the arrow with the plus sign in it will get you to the next sequence, and clicking the third symbol will load the thumbnails (study overview).

You can also use the menu to navigate (menu entry "Navigate"):



Keyboard shortcuts offer another alternative for navigation:

**previous sequence:** (PgUp)  
**next sequence:** (PgDn)  
**display thumbnails:** (Home).

## 2.4. Video Edit

The "Video edit" dialog box is automatically shown when the image is ready for editing (i.e. when loading is finished).

The previously edited sequence is kept until you display the DICOMDIR images again to select another sequence.

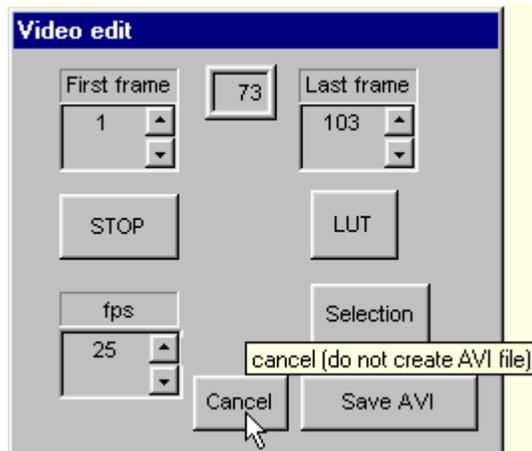
As long as the "Video edit" symbol () is lit (i.e. not grayed) you can press this symbol to (re-)edit the current sequence.

After you press "Video edit" the cine will always be run in real-time, i.e. it is shown with the frame rate which was used to record the sequence. This rate is shown in the "fps" (frames per second) field. The cine is always shown as a loop, initially looping through the sequence as it was recorded. The current frame number is shown in the framed field in the upper center of the dialog box.

Now you have a number of options:

- enhance the image (similar to changing brightness and contrast), but activating the "[LUT](#)" button and by changing the slider setting in the "[Grayscale enhancement](#)" dialog box
- exclude any number of frames from the beginning and/or end of the sequence (use the arrows [spin buttons] inside the fields "First frame" and "Last frame")
- display [single frames](#) (by pressing the STOP button)
- [select a rectangular area](#) for DICOM => AVI-conversion (see "Selection Rectangle")
- [store the sequence](#) (in its current edited format: all modifications will be used for the conversion process) as an AVI file
- [change the frame rate](#)
- [magnify the image](#)

- [copy the current frame to the clipboard](#)
- cancel the "Video edit" process ("cancel" button)



You cannot enter numbers into the gray fields from the keyboard. To change the numbers activate the spin buttons by using the mouse or by selecting a field with the TAB key and by changing the numbers with the "up" and "down" cursor keys.

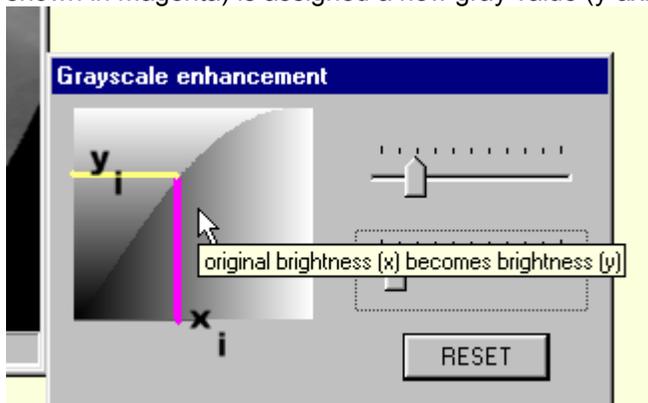
The current sequence remains loaded if you "cancel". You can start the "video edit" dialog again by pressing : the "Video edit" dialog will be shown again.

If the frame-to-frame intervals are defined by a "frame time vector" you will see specific information on the lower left corner of the video edit dialog box (see [FAQ #11](#)).

## 2.5. Grayscale enhancement

Two [sliders](#) are used to modify a grayscale look-up table ("LUT"). This table maps each pixel value to a new pixel value.

The graph inside the graph field on the left side of the dialog box shows how each original image pixel (x-axis, shown in magenta) is assigned a new gray value (y-axis, shown in yellow).



Both sliders are used to modify the mapping algorithm. You can either use the mouse to change the sliders or select them with the TAB key and use the arrow keys on the keyboard to change slider position.

Dramatic improvements in image quality can result. It is difficult to predict what the best mapping curve should look like: this depends on the original images and on the entire video chain (video card+monitor/projector), subjective factors are also important.

Please be aware of the fact that a setting which really improves the images on one computer may not necessarily

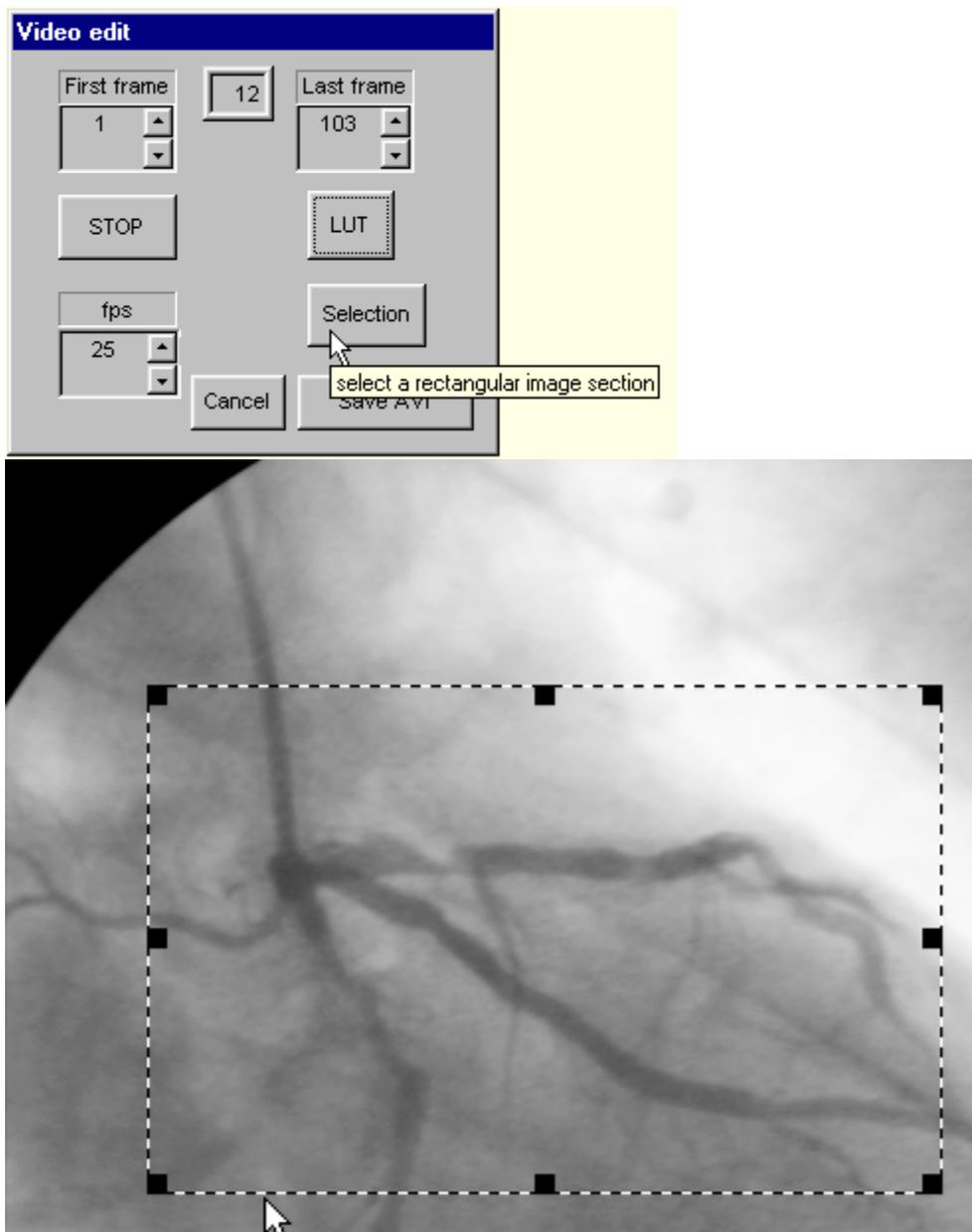
be the best setting for displaying the same sequence on another computer (different gamma and other factors are responsible for this). It is essential to be aware of this when it is intended to use a different computer to show the AVI file.

It takes some experimenting to get a feel for "good" slider settings. Just use trial and error.

If the cine gets way too dark or too bright you can always reestablish the original mapping (= no mapping function) by clicking "RESET".

Close the "Grayscale enhancement" box by clicking "LUT": this will also delete any mapping function and restore the original grayscale values.

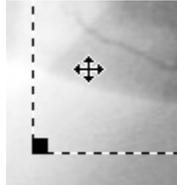
## 2.6. Selection Rectangle



"Selection" activates a selection rectangle which has 8 handles.

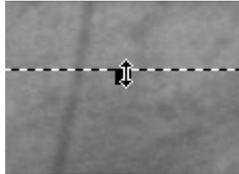
The cursor changes when it gets close to one of the handles; it can take either one of these 2 shapes:

- **four-way arrow**



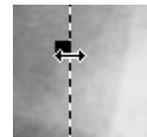
this indicates that the entire selection rectangle can be moved

- **two-way arrow**

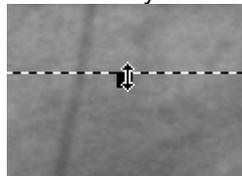


this indicates that the selected border can be moved (i.e. the rectangle is enlarged or reduced in size)

If you move the entire rectangle it will get smaller when one of its borders touches one of the image borders. If you do not let go of the mouse button and move the rectangle back to the center it will grow back to its original size. Manipulating the selection rectangle is quite intuitive and easy.

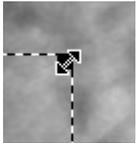


The two-way arrow indicates that you can move one of the rectangle's borders: a vertical



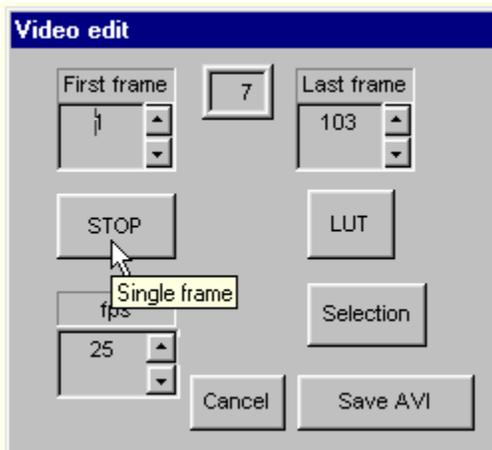
or a horizontal border

If you hit one of the corners the cursor will assume a diagonal two-way shape which indicates that the 2 adjoining borders can be moved.



## 2.7. Single Frame Mode

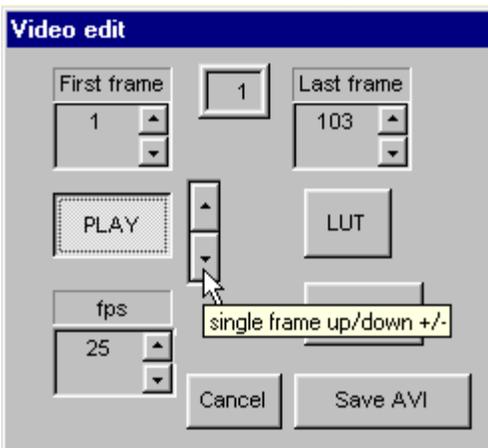
The cine stop when you press the "STOP" button and the "STOP" button lights up and is now called "PLAY".



Two spin controls appear next to the "PLAY" button.

You can use these spin controls to navigate within the sequence. Be aware that you cannot go to any frame before the "First frame" or to any frame beyond "Last frame". You need to use the "down" spin control to move back to the initial frame; there is no "loop" mode when you are looking at single frames.

The current frame number is shown in the framed field in the upper center of the dialog box.



These functions continue to have unrestricted functionality even in single frame mode:

- [Grayscale enhancement](#)
- [Selection rectangle](#)
- [Magnification](#)

After switching to single frame mode you can

- [copy the current frame to the clipboard](#) (that feature works for single frame and cine mode)
- [export the current frame as a bitmap file \(\\*.bmp\)](#)
- [print the current frame](#)

Resume cine mode by pressing "PLAY".

## 2.8. Magnification

Pressing the right mouse button inside the image activates image magnification (this works while displaying cines as well as in single frame mode, but not while a sequence is being loaded). The magnification factor is 1.6. Just hold the right mouse button and move the mouse to pan the image. The magnification factor is shown on the [status bar](#).

Any [selection rectangle](#) will disappear as long as you are magnifying the image; the selection rectangle is restored as soon as you let go of the right mouse button.

## 2.9. Frame Rate

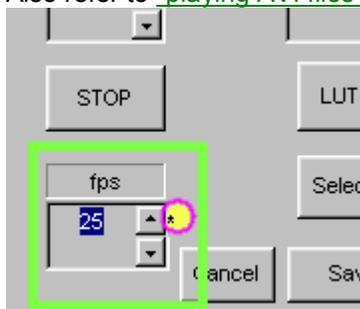
After an image sequence is loaded the cine is immediately played back with the frame rate it was recorded with. If you would like to change the playback speed (and the speed used for playing the AVI file generated from this sequence) set a new frame rate by activating the spin controls inside the "fps" field. You can set any frame rate from 5 to 35 frames/sec.

If your computer is not fast enough to show the cine with the selected rate a small (!) asterisk (see below) will show up just to the right of the spin control (see sample below).

Remark:

***Even is the asterisk pops up it is assured that the AVI file generated from this sequence will be played back with the desired rate: most computers which cannot handle real time playback when in "video edit" mode are sufficiently fast to show AVI files with higher frame rates (this is due to fact that AVI is a compressed format).***

Also refer to "[playing AVI files](#)".



The screen display will only show a black asterisk, there will be no color markings.

## 2.10. Clipboard Support

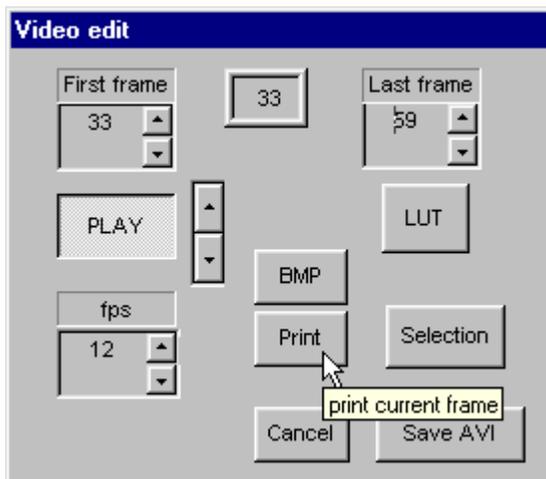
Whenever you see the clipboard symbol () on the toolbar and when it is not grayed you can either click on the symbol or use the standard keyboard shortcut "Ctrl + c" to copy the current frame to the clipboard. This will even work when you are in cine mode (PLAY mode as opposed to [single frame mode](#)).

If the [selection rectangle](#) is active, only the selected area will be copied.

Use the usual "insert" command ("Ctrl + v") or the appropriate toolbar symbol or menu entry in another Windows application to copy the image into your application.

## 2.11. Print Frame

Single frames can be printed by pressing the "print" button (see illustration). This option is only available if you are in single frame mode:



CarDiCon will use the default printer, unless you selected a different printer ("File/Print setup"). Please make sure the printer is set to its **highest** quality.

The printed frame will not look identical to the frame on the screen, because CarDiCon uses a contrast-enhancement technique before a frame is sent to the printer. User defined grayscale modification is also ignored when a frame is printed.

The image will always be centered on the page; its size is automatically adjusted to the paper.

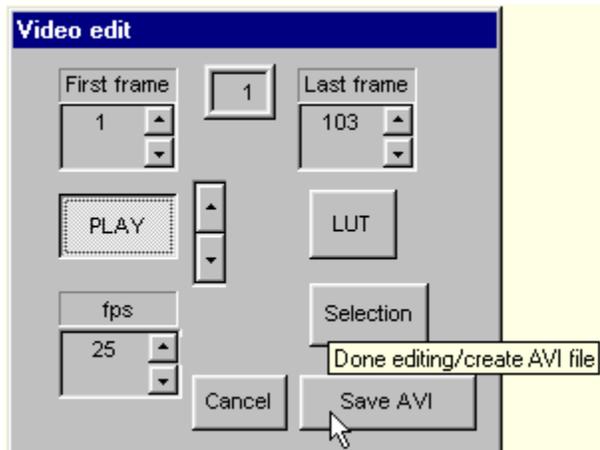
## 2.12. Export Frame

The current frame can be written to a bitmap file (\*.bmp" format) for later use with a graphics program. CarDiCon exports the **original** image (just extracted from the DICOM file and decompressed). Any user modification (grayscale, clipping) is ignored. Why is that? CarDiCon wants to provide access to the unadulterated data to permit later processing by a graphics program.

After clicking the "export" button a file name dialog appears. Select a file (or type a file name) and hit OK to store the frame. There is no need to add the "bmp"-postfix; CarDiCon adds the postfix.

## 2.13. Save AVI File

Storing the edited sequence (all current parameters are kept when the AVI file is prepared: grayscale enhancement, possible selection, frame rate, first image, last image) is as simple as pressing the "Save AVI" button.



A new dialog box opens for you to enter path and file name for the AVI file.

**This screen snapshot contains additional hints (simple click on the dashed rectangles):**

There is no need to specify the ".avi" postfix when you enter a file name, CarDiCon adds ".avi" automatically. This dialog box is equivalent to the "Save as" dialog box you are familiar with from other Windows applications. You can cancel the file save operation by clicking "cancel".

In case you specify a file name that is already in use in the same path, the system will query you if you intend to overwrite the existing file.

Creating the AVI file may take several minutes; the progress is shown on the status bar.

You cannot interrupt this operation.

If you decide to re-use the sequence (e.g. to convert another image segment) you can reactivate "video edit" by pressing the  toolbar symbol.

To select another sequence have CarDiCon display all sequences by pressing . You can insert a new CD **before** you press .

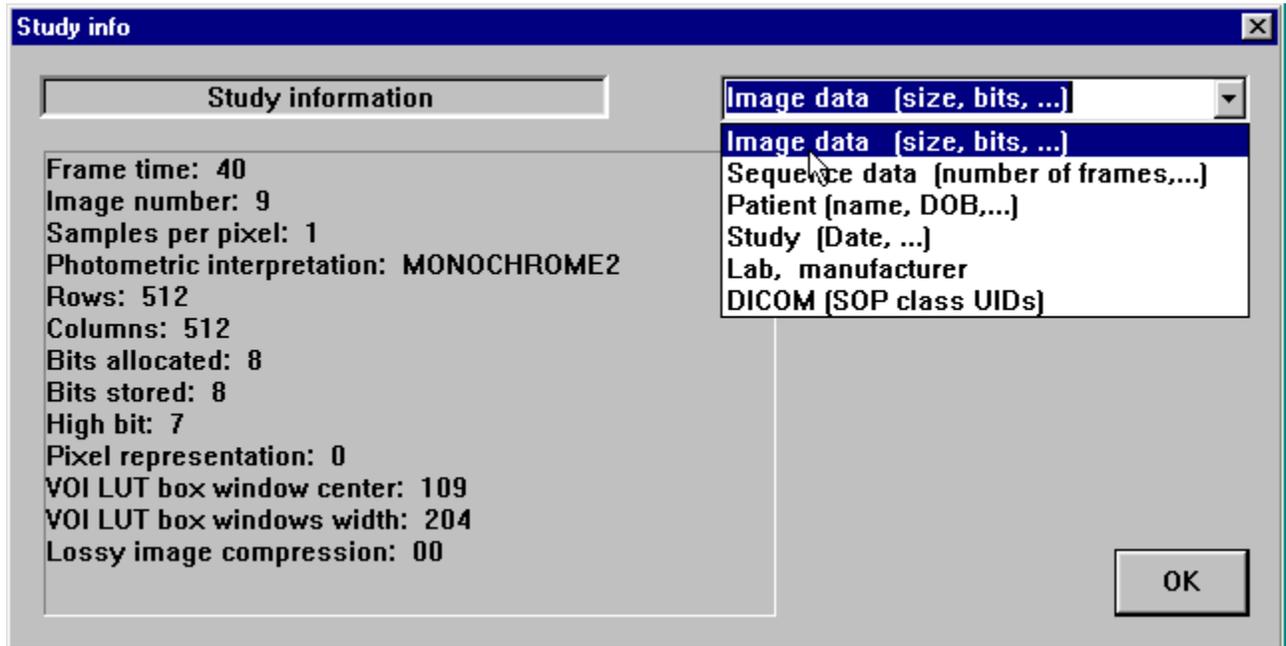
## 2.14. Study info

You can examine alphanumeric study details (extracted from the DICOM file) as soon as CarDiCon loads images.

Study details comprise:

- **Image data** (image size, bits per pixel, etc. -- see example below)
- **Sequence data** (number of frames, beam angle, ...)
- **Patient** (name, DOB, [if these data were entered when the file was recorded])
- **Study** (Date)
- **Lab** (Institution, equipment manufacturer [sometimes missing])
- **DICOM** (SOP class UIDs etc., usually of no interest)

The "Study info" dialog box opens when you activate "Edit/Study info". Select the desired topic from the combo box (e.g. "Image data" as in the example shown below). The alphanumeric data will appear to the left of the combo box.

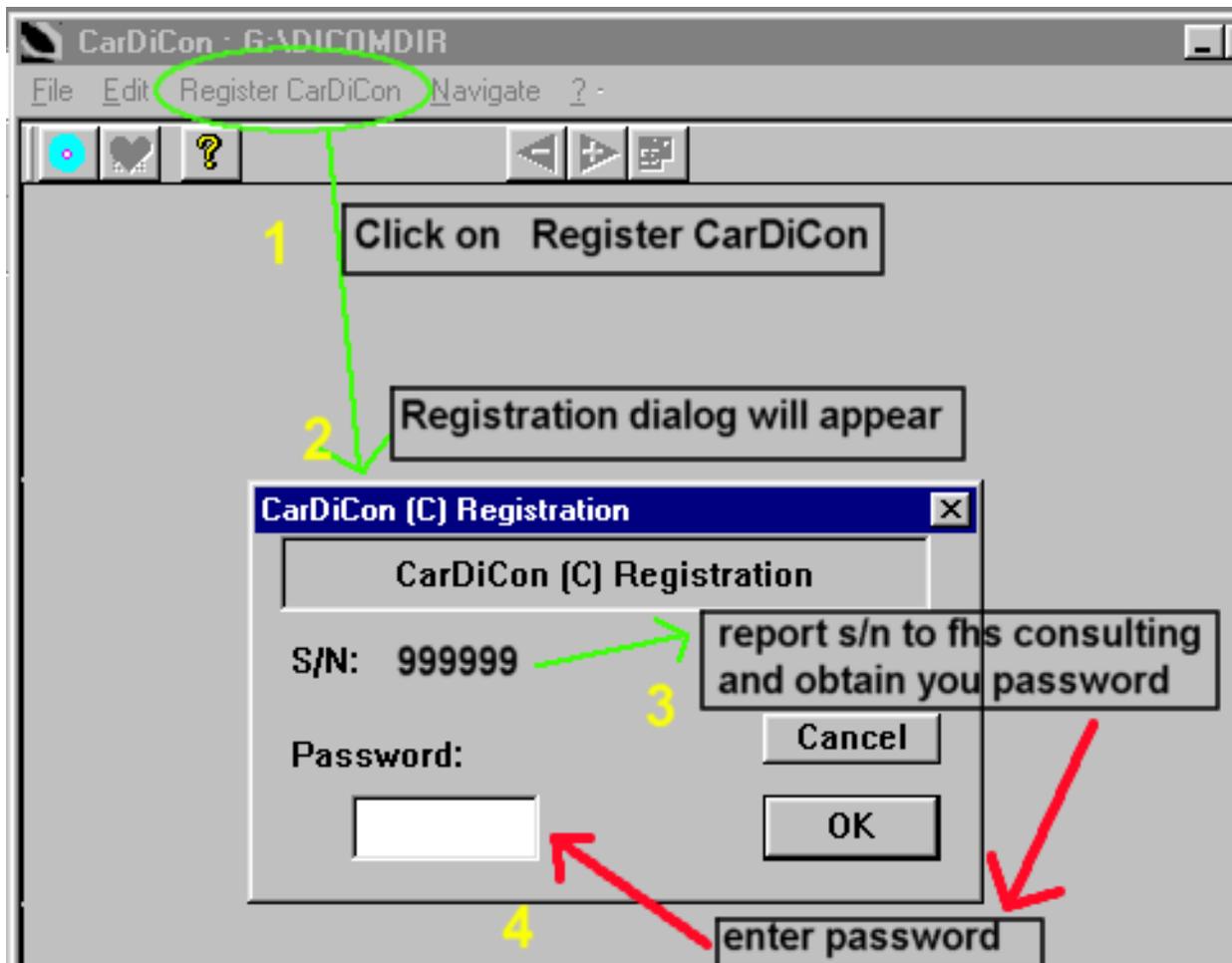


## 3. Licensing CarDiCon

### 3.1. Licensing

You need to install the free demo version before you go through the licensing process. The only difference between the demo version and the licensed version is that the demo version writes a registration banner into the AVI-files and the registered version does not.

To register you first have to retrieve your CarDiCon serial number (S/N: this number depends on your computer and user name). Click on "Register CarDiCon" and you will see the registration dialog box. Report your 6-digit serial number to "[fhs consulting](#)" to obtain your 7 digit password, WRITE DOWN YOUR PASSWORD AND KEEP IT IN A SAFE PLACE, enter the password and hit "OK". The program will tell you if the registration process was successful. Make absolutely sure to keep a record of your password; you may need it in case you have to reinstall CarDiCon.

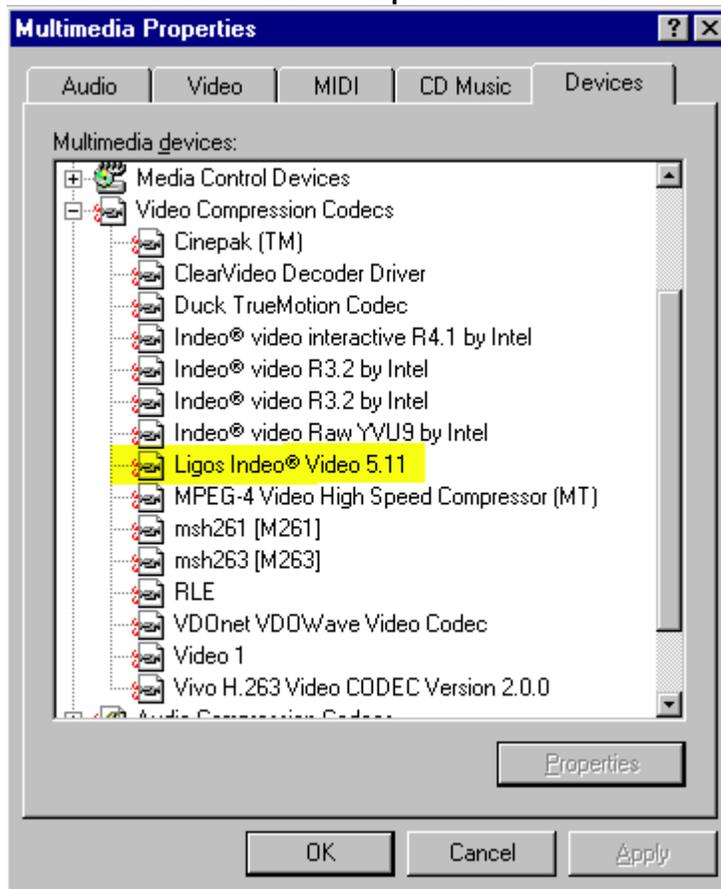


Feel free to contact [fhs consulting](#) for assistance.

## 4. Playing AVI Files

### 4.1. Playing AVI Files

- All you need to view AVI files on a computer that has CarDiCon installed is an appropriate program (e.g. Microsoft Media Player). AVI files generated by CarDiCon can be shown on other computers as well if a specific codec\* (Ligos Indeo (R) video 5.1 Codec [or later version]) is installed. This codec can be found on many computers.
- **How can you tell if the codec is installed?** Simply activate **START/Settings/Control Panel/Multimedia/Devices/Video compression codecs**:



- **What can you do if the codec is not installed on the system you intend to use to play AVI files generated by CarDiCon?**

There are two options:

- either install CarDiCon (the demo version suffice)
- download the codec installation package from Ligos ([www.ligos.com](http://www.ligos.com))

\* What does the term "codec" mean?

A codec ("compression/decompression") is the software for generating videos. A whole array of codecs are available from various companies. AVI files saved with CarDiCon require the Ligos Indeo (R) Codec 5.1 (or a later version).

## 5. Extensions

### 5.1. Extensions

***CarDiCon's future depends on your input!***

Here are some examples for possible future additions:

- **image enhancement techniques** (image filtering, pattern recognition, ...)
- **option to save sequences as animated GIF files**
- **echo** capabilities
- **curve data** (pressure, ECG, ...)

Updates will be available as downloads from the CarDiCon website.

Any suggestions are very much appreciated; please contribute to CarDiCon's future by contacting [fhs consulting](#) about any suggestions/critique.

## 6. FAQ

### 6.1. FAQs

#### 1. What is the difference between the 2 grayscale sliders? Why don't they have names?

Each slider defines one of 2 parameters of a mathematical function. Despite the obvious changes in brightness and contrast neither slider affects just brightness or contrast alone. No suitable name (except for maybe something like "parameters a and b") can be assigned to either slider.

The easiest technique is to let yourself be guided by the image quality or by the mapping function depicted in the [grayscale enhancement](#) box.

#### 2. Why does the program sometimes complain there is no DICOM-CD even if a CD is in the drive?

The operating system cannot read CD data until the drive is up to speed. You may have to activate "DICOMDIR" (or press the toolbar symbol  ) more than once for the file transfer to start. Also refer to [Load CD](#).

Make sure the CD is really a DICOM CD, ascertain that it is properly seated in the drive and that the drive door is closed.

#### 3. I have several CD drives connected to my computer. Which one does CarDiCon use?

CarDiCon will find ALL DICOM CDs in ALL drives. If CarDiCon finds more than one suitable DICOM CD you will be asked to remove all CDs except for the one you would like to view. It does not matter which drive you use.

#### 4. I know that DICOM CDs contain sequences compressed with a lossless technique and sequences compressed with a lossy technique. Which ones are used?

CarDiCon processes the sequences which are compressed with the lossless technique.

#### 5. I would like to see a feature added or something changed. Whom do I approach?

Contact [fhs consulting](#). Any suggestions are highly appreciated. Also see ["Extensions"](#).

#### 6. What exactly are those images displayed when I click "DICOMDIR"?

These images are called "icon images"; they are part of the CD's directory ("DICOMDIR"). These images are supposed to be 128x128 pixels in size. Each image represents a typical image of one sequence. The DICOM standard recommends to select an image from the end of the first third of each sequence.

#### 7. When may I insert a new DICOM CD?

As long as you do not open the drive while CarDiCon reads from it (most drives will have an indicator LED to show when they are being accessed) you can change CDs any time. CarDiCon will recognize that a new CD has been inserted and will re-read the overview when necessary.

#### 8. Why do the printed images look different from the ones displayed on the computer screen?

A contrast enhancement technique is used to achieve reasonable images on any printer capable of printing graphics. **The grey scale enhancement sliders do not affect the printouts at all**, the image enhancement sliders are only for the screen.

#### 9. Why do exported single frames look different from the single frames displayed on the computer screen?

Single frame export takes the raw decompressed images from the DICOM file, the grey scale enhancement

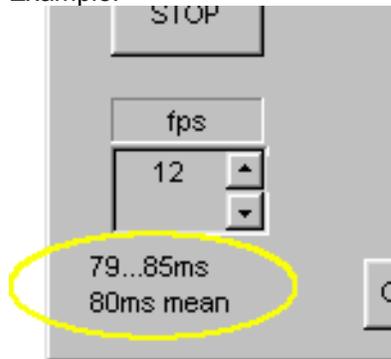
sliders do not affect the exported single frames. This is done to give you an opportunity to import the unadulterated images into a graphics program for processing. If this bothers you: you can work around this by exporting AVI files with just single frames (set the "1st frame" equal to "last frame" in your video edit dialog and save the resulting "single frame loop" as an AVI file).

#### 10. How can I install a new version of CarDiCon without losing my registration?

IMPORTANT: Do not uninstall any previous CarDiCon version when you upgrade to a new one. The installation program is smart enough to replace the old version while maintaining your registration status. DEINSTALLATION WILL DESTROY THE REGISTRATION INFORMATION.

#### 11. What do those numbers mean which will occasionally show on the lower left corner of the video edit dialog window?

Example:



Some DICOM file specify frame-to-frame intervals instead of a constant frame to frame interval. The various intervals (between frames 1 and 2, frames 2 and 3 ,... etc.) are stored in what is referred to as the "frame time vector". CarDiCon will average all intervals (example: 80 ms ... which translates into a frame rate of 12.5 frames/sec). What you see displayed are the minimum, the maximum, and the mean interframe intervals. Note: The mean is calculated from *all* intervals - that is why it is not necessarily equal to the average of the min and max values.

#### 10. When starting CarDiCon I get a message that the software can only function as a viewer, and cannot create AVI files. How did that happen?

This will most frequently be due to CarDiCon having been installed by a person logged in without administrator privileges. On many Windows NT systems, administrator privileges are required to install all software components. Please do not hesitate to contact [fhs consulting](#) if you need any help installing CarDiCon.