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## Image Tools 1.0

Allows to simulate schematic arrays of regular structures, such as camera chips, neural nets, filters or other wide matrix designs, with a direct image input and then allows to read an output simulation values as an image again.

Image Tools are included into Cadence system and are accessible from a CIW pull-down menu.

Image Tools consist of two main functions

- Loading one or more pictures into a schematic
- Extracting one or more pictures from transient simulation data file

Colours from the input image are transferred to voltage or current values and placed into a voltage or current sources in schematic array. After filling the sources, running transient simulation and getting transient simulation results as raw data file it is possible to extract a design's response as an image.

The input image format is Windows bitmap format and only 16 or 256 colour pictures are supported.

The output image format is Windows bitmap format with 256 grey scale levels.

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### Abbreviations

CIW	Command Input Window of Cadence system
Pixel	Picture element

## Installation

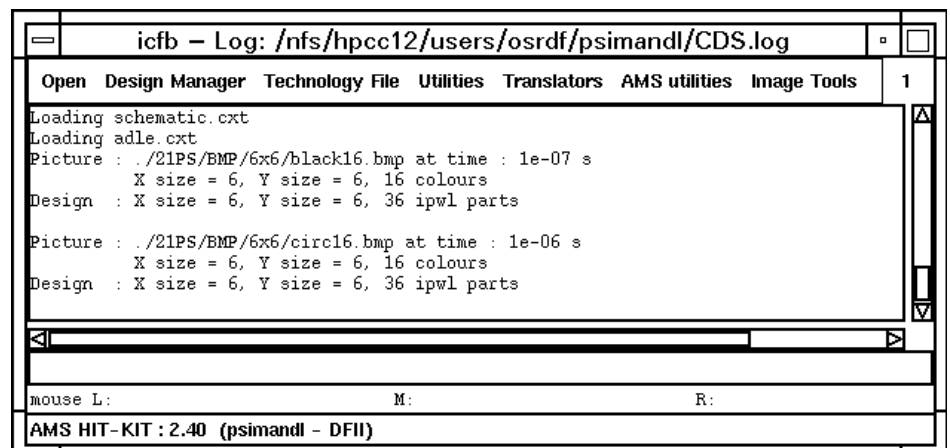
All environment and functions are included in file `Image_Tools.il`. To load these functions to Cadence system type in CIW window next command:

```
loadi( "/path/Image_Tools.il" )
```

Where `/path/` is a directory location of `Image_Tools.il` in your system. Then type in CIW window next command to insert Image Tools menu in CIW banner:

```
V_image_tools_banner( )
```

Because of this function the pull-down menu **Image Tools** appears on the last position in CIW banner and allows choosing all actions by mouse.



In the directory

```
./trans
```

must be installed conversion program `trans`, which is necessary for Image Tools extract function. Path `./` means working Cadence directory.

## Settings

This section introduces how to change settings of Image Tools.

Settings of Image tools are accessible from the Image Tools form. To display the Image Tools settings form select from CIW menu banner Image Tools → Settings. This form together with pull-down menu makes up an user interface of Image Tools.

Image Tools	
OK	Cancel Defaults Apply Help
Cell name	sim_pixel_BiCMOS_final_50x50_03
Simulation directory	./Sim
<hr/>	
Number of input images	2
Input images directory	./21PS/BMP/6x6
Input device	ipwl
Input parameter	i
Input range	5e-08
CIW load messages	info 1L
<hr/>	
Number of output images	1
Output images directory	./21PS
Extract variables ( $y = Ax + B$ )	auto 1L
Multiplication variable A	32603.2
Shift variable B	-76825.4
CIW extract messages	info 1L
<hr/>	
Time of input image 1	1e-07
Name of input image 1	black16.bmp
Time of input image 2	1e-06
Name of input image 2	circ16.bmp
<hr/>	
Time of output image 1	1.4e-06
Name of output image 1	out1.bmp

Form consists of five parts. These parts are separated by horizontal double lines.

Items in the first part are common for all Image Tools functions and are situated on the top of form.

The second part includes settings for Load image function.

The third part includes settings of Extract Image function.

The fourth part includes times and names of input images.

The fifth part includes times and names of output images.

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## Fields

Cell name	Cell name of used design.
Simulation directory	Simulation directory with full path.
Number of input images	Number of input images. Form is adapted by this number.
Input images directory	Input images directory with full path.
Input device	Cell name of used input voltage or current source.
Input parameter	Input variable type. "v" for voltage or "i" for current.
Input range	Maximum input voltage or current variable value.
CIW load messages	Enabling or disabling Load image messages in CIW window.
Number of output images	Number of output images. Form is adapted by this number.
Output images directory	Output images directory with full path.
Extract variables ( $y=Ax+B$ )	Enabling or disabling automatic setting variables A and B.
Multiplication variable A	Variable A.
Shift variable B	Variable B.
CIW extract messages	Enabling or disabling Extract image messages in CIW window.
Time of input picture 1	Time of input picture 1
Name of input picture 1	Name of input picture 1
Time of input picture 2	Time of input picture 2
Name of input picture 2	Name of input picture 2
Time of output picture 1	Time of output picture 1
Name of output picture 1	Name of output picture 1

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## Configuration file

Content of Image Tool form is automatically saved to the file  
`./image_tools_config`

Path `./` means working Cadence directory. When this file is not found a new default one is created.

## Load image

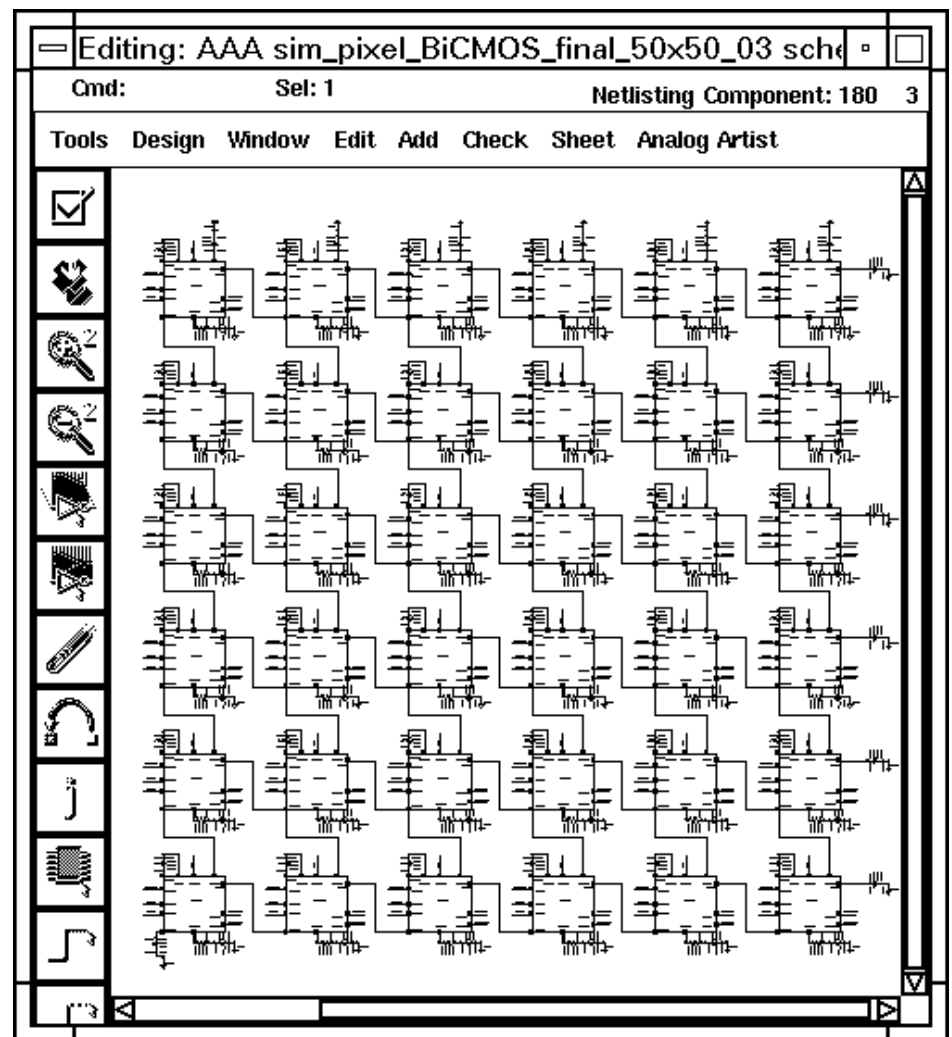
This section introduces how to load an image into a schematic.

To load one or more images into the schematic follow these steps

1. Select from CIW Image Tools → Settings and set all items in first, second and fourth part of Image Tool form to appropriate values.
2. Open a schematic from Library browser in editable mode.
3. Select from CIW Image Tools → Load image function.

### Example

An example of schematic is shown below.



This schematic consists of an array of 36 cells. Input of each cell is realized by current source `ipwl` distributed in standard library `analogLib`. These sources are arranged in six rows and six columns. Function `Load image` assigns sources in schematic to pixels in input image and charges sources with corresponding values computed by next formula

$$Source\_value = Input\_range(K_r R + K_g G + K_b B)$$

where R, G and B are values of red, green and blue parts of pixel colour and constants  $K_r=0,3$ ,  $K_g=0,59$  and  $K_b=0,11$  are set by correspondent colour part supply to common light intensity received by a human eye. These three constants can be modified by attributes of other used detector.

The smallest image, which can be loaded into this schematic, is 6x6 pixels. If the size of image is bigger only a part in left down corner of picture is used and the rest of the image is omitted.

## Extract image

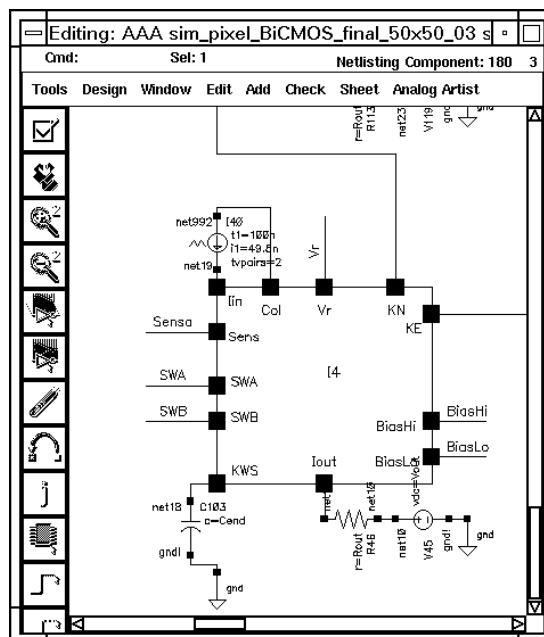
This section introduces how to extract an image from results of transient simulation. These results must be stored in raw data file in psfbin format as voltages. Currents are not supported.

To extract one or more images from results of transient simulation follow these steps

1. Select from CIW Image Tools → Settings and set all items of Image Tool form to appropriate values.
2. Open a schematic from Library browser in editable mode.
3. Select from Edit schematic window Tools → Analog Artist.
4. Select from Edit schematic window Analog Artist → Simulation.
5. Select from Simulation window Analysis → Choose and choose the transient analysis.
6. Select from Simulation window Analysis → Run
7. Select in Edit schematic window a reference net in left down corner of schematic array.
8. Select from CIW Image Tools → Extract image function.

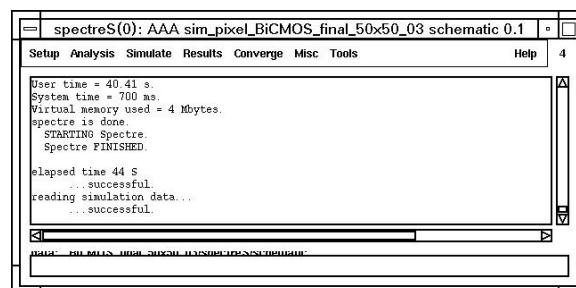
### Example

An example of left down corner of schematic array is shown below.

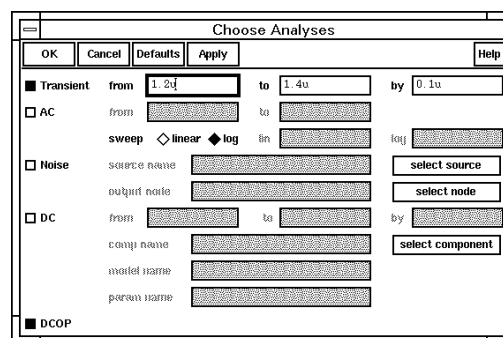


The output signal is a current. Because currents are not supported this current output signal is transferred to voltage by resistor and the output of schematic design is taken from the connection net between pin Iout and resistor R46. In left upper corner is connected input current source I40.

Select Analog Artist → Simulation and choose a simulator, which is able to give output results from transient analysis in psfbin format. When spectreS simulator is chosen then spectreS Simulation window appears.



Select from Simulation window **Analysis** → **Choose** and choose the transient analysis and set the time interval. It is recommended to use just interval around of the desired output image time because it causes smaller size of the output transient simulation raw data file and shorter time of Extract image operation as well.



Select from Simulation window Analysis → Run

After executing transient simulation select by mouse the net, which is the connection net between pin Iout and resistor R46.

Select from CIW Image Tools → Extract image function.

If all arguments in the Settings form are valid in the specified output image directory is the output image in Widows bitmap format. Size of this image is as same as the size of schematic design array 6x6 pixels.



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## SKILL functions

This section describes syntax and required parameters of Image Tools functions when using CIW command line or calling from another SKILL function.

All Image Tools function names are prefixed by `V_`. All Image Tools variable names are prefixed by `VL_`.

<code>V_load_BMP</code>	Loads image into a schematic.
<code>V_extract_BMP</code>	Extracts image from transient simulation results.
<code>V_image_tools_banner</code>	Installs Image Tools pull-down menu on CIW menu banner.

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## V\_load\_BMP

```
V_load_BMP(
    VL_name_BMP
    VL_input_device
    VL_step
    VL_time
    VL_name_parameter
    VL_input_range
    VL_out
    VL_inf
)
⇒ t / nil
```

---

### Description

Loads an image in bitmap format to an array of sources contained by current schematic window.

Sources are either voltage or current type and must be arranged in proper columns and rows to compose regular rectangle.

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### Arguments

<i>VL_name_BMP</i>	Name with full path of the input image in Windows bitmap file format. The image must be in bitmap format with either 16 or 256 colours only. String.
<i>VL_input_device</i>	Name of current or voltage source part used as input of schematic. Only sources "vpwl" and "ipwl" are supported. String.
<i>VL_step</i>	Position number of input image. String.
<i>VL_time</i>	Time of input image. Float.
<i>VL_name_parameter</i>	Input variable type. "v" for voltage or "i" for current. String.
<i>VL_input_range</i>	Maximum input voltage or current variable value. Float.
<i>VL_out</i>	If set to <i>nil</i> , no extended message will be sent to CIW window. Boolean.
<i>VL_inf</i>	If set to <i>nil</i> , no basic message will be sent to CIW window. Boolean.

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### Values Returned

*t* Returns *t* if the image is loaded.  
*nil* Returns *nil* if an error occurred.

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**Example**

An example of loading an image at time 100ns into ipwl type current sources. The white colour in image is represented by 50nA value.

```
V_load_BMP( "./21PS/BMP/6x6/black16.bmp" "ipwl"  
            "1" 1e-7 "i" 5e-8 nil t )
```

---

## V\_extract\_BMP

```
V_extract_BMP(
    VL_input_device
    VL_raw_file_name
    VL_name_BMP
    VL_time
    VL_extract_var
    VL_KA
    VL_KB
    VL_out
    VL_inf
)
⇒ t / nil
```

---

### Description

Extracts a bitmap format image from the transient simulation result raw file of the current schematic window with an array of nets. A net in the left down corner of the array must be chosen before calling this function. This net is taken as a reference net for extracted image.

The output image is created in text format because of lack of possibility to write a byte to a file in SKILL language. Then is converted to a normal binary form by an external program. This external program is called `trans` and is called automatically after creation text version of the output image. Usage of this converter:

```
./trans/trans <input text file> <output binary
file>
```

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### Arguments

<i>VL_input_device</i>	Name of current or voltage source part used as input of schematic or a name of an electrical part, which is contained in each cell of schematic array. String.
<i>VL_raw_file_name</i>	Name of the raw data file with full path. This file must contain output results from transient simulation in psfbin format. String.
<i>VL_name_BMP</i>	Name of output image with full path. String.
<i>VL_time</i>	Time position of output image in raw data file. Float.
<i>VL_extract_var</i>	If set to "auto", constants A and B will be set automatically to use all range of grey scale in output image. If set to "constant", two constants below will make effect in the output formula. String.
<i>VL_KA</i>	Maximum input variable value. Float.

<i>VL_KB</i>	Maximum input variable value. Float.
<i>VL_out</i>	If set to <i>nil</i> , no extended message will be sent to CIW window. Boolean.
<i>VL_inf</i>	If set to <i>nil</i> , no basic message will be sent to CIW window. Boolean.

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### Values Returned

<i>t</i>	Returns <i>t</i> if the image is extracted.
<i>nil</i>	Returns <i>nil</i> if an error occurred.

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### Example

An example of extracting an image from transient simulation raw data file in psfbin format at time 1,4µs.

```
V_extract_BMP( "ipwl"
  "/Sim/sim_pixel_BiCMOS_final_50x50_03/spectre
  S/schematic/psf/timeSweep.tran"
  "/21PS/out1.bmp" 1.4e-6 "constant" 32603.2
  -76825.4 nil t )
```

Argument *VL\_extract\_var* is set as "constant". This causes those variables A and B will be set by values 32603.2 and -76825.4. The output formula for colour number will be

$$\text{Colour\_number} = \text{round}(32603.2 * \text{Net\_voltage} - 76825.4)$$

The output image format is Windows bitmap format with 256 grey levels. Allowed are only colours with numbers from the interval 0 .. 255. If the result colour number is lower then 0 then colour number is forced to 0 and if the result colour number is higher then 255 then colour number is forced to 255.

When *VL\_extract\_var* is set as "auto" constants A and B are set automatically to assign the lowest net voltage value to colour number 0 and the highest net voltage value to colour number 255.

Minimum and maximum values are prompted in CIW when *VL\_inf* argument is set to *t*.

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## V\_image\_tools\_banner()

```
V_image_tools_banner(  
  )  
⇒ t / nil
```

---

### Description

Creates and installs Image Tools menu to CIW menu banner.

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### Values Returned

*t* Returns *t* if the banner is installed.  
*nil* Returns *nil* if an error occurred.

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### Example

An example of installing the Image Tools menu to CIW.  
V\_image\_tools\_banner( )