

Wavemaker User Manual

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1 Overview

Wavemaker is a program designed to help with the production of custom ('User') waveforms for the Syscomp¹ WGM-101 waveform generator.

The program's main feature is a drawing window, in which the mouse can be used to draw a waveform shape onto a canvas. The drawing can be edited, and the result saved into a data file compatible with the requirements of the WGM-101.

Although waveforms can be drawn directly by hand, the main purpose of the program is to allow them to be traced from a scanned picture, which may for example be obtained from a printed or hand-drawn source.

The WGM-101 expects waveform data as a set of 256 sample values, each representing a voltage level and each in the range 0–255 where 0 represents the peak positive voltage, and 255 represents the peak negative voltage. The full set of 256 samples describes one cycle of the waveform. In normal use of the program, the steps to be followed are:

1. Prepare the background picture of the waveform, using scanner software and/or an image editor.
2. Run wavemaker, and load the picture.
3. Adjust the horizontal axis marker to span one full cycle of the waveform in the picture.
4. Use the mouse to draw a trace line over the waveform. There is a zoom feature to make this process easier, and sections of the line can be erased and redrawn until they're right.
5. Select the 'See Result' mode, which superimposes a histogram-like display of the sample values calculated from the trace line.
6. If desired, drag individual sample lines vertically to clean up the waveform. This can be particularly useful if there are vertical edges.
7. Save the result to a data file, which may then be loaded into the WGM-101.

2 Preparing the Background Picture

Note: If you only want to draw a waveform in freehand style, you can omit this step.

The picture needs to be in a file format that the program can handle. Assuming that the original picture is on paper, the first step is to scan it. The method will obviously depend on your operating system and what scanner software you have, but the result will be an image file of some sort.

It's then usually a good idea to use an image editor program to clean up the result. You can use something like PhotoShop if you have it. I use The Gimp², which is free and has all the needed functionality. It's available in versions for Linux, Mac and Windows.

It's not critical, but a useful image size is one in which a cycle of the waveform occupies 500 pixels or so horizontally. You should crop the image to leave a small margin around the waveform – large margins will cost memory and speed at high zoom levels. The left and right margins should each be at least 10% of the width of one cycle of the waveform, to allow the adjustments described in Section 8.1. More than 10% does no harm, but is not necessary.

When you save the result, PPM, PGM or GIF formats will work, or you could use JPEG or a pixmap if you have the Tk 'Img' package installed. It's worth making sure that the

¹<http://www.syscompdesign.com/>

²<http://www.gimp.org/>

image size is less than your screen size – if it's larger, I think you'll find it inconvenient to work with.

2.1 Working Without a Background Picture

If you don't use a background picture, you'll find that the drawing area available to you is restricted by the window size. Or to put it another way, the scroll bars won't let you move outside that area.

If that's a problem, just use an image editor to prepare a dummy picture which is an all-white image of the size you'd like to work with. Load that as the background picture, and it will give you the space you need.

3 Running the Program

Under Linux, run the program with

```
cd wherever-you-saved-the-program
wish wavemaker.tcl
```

On other platforms, do whatever you have to do to run the `wavemaker.tcl` Tcl/Tk script. (Anyone want to help me out here?)

When the program starts up, select 'Load Picture' from the File menu, and use the file dialog box to open the file containing the background picture. The picture will appear in the drawing window, together with the horizontal axis marker. The horizontal axis marker is a magenta line with a circle at each end.

4 Adjusting the Horizontal Axis Marker

When the program starts up, it will be in 'Adjust Axis' mode, as you will see from the radiobuttons at the bottom of the window. In this mode, the cursor (when the mouse is over the drawing area) is a small dot. What you need to do is to drag the ends of the axis marker so that the marker spans exactly one cycle of the waveform in the background picture.

To drag an end of the marker, position the mouse on the rim of the corresponding circle, and drag that. The end of the axis line (in the middle of the circle) should be positioned on the waveform.

The vertical offset of the marker doesn't matter, so you can choose any convenient point on the waveform to mark the cycle. The marker is not constrained to be horizontal, and you can use this to compensate if the scanned image is not quite squarely oriented. When sample values are calculated, the calculation uses the vertical distance between the trace and the axis marker at each point.

The Options menu has an entry which lets you change the colour of the axis marker if you wish.

5 Tracing the Waveform

To begin tracing the waveform, select 'Draw' mode using the radiobutton at the bottom of the window. The cursor will change to a pencil, and you can now use the mouse to draw a line on the screen following the waveform shape. The line can extend past the ends of the axis marker, but only the part within those limits will be used.

Accurate drawing with a mouse is not easy, and you'll probably want to use the Zoom menu to magnify the picture. Zoom levels provided are 1, 2, 4 and 8. Use whichever you find suits you best. Note too that Section 7.2 describes how to zoom in onto a specific point in the drawing.

By default, lines you draw will be in red and will be one pixel wide. The Options menu lets you adjust both colour and width. At high zoom levels, it's often a good idea to increase the width.

You don't have to trace the whole waveform cycle in one drawing stroke. Use as many strokes as you like, and you can draw them from left to right or from right to left. The only thing that doesn't make sense is to have strokes that double back on themselves horizontally. If you do draw such a stroke, the program will automatically edit it when you release the mouse, to remove the overlap. If you don't like the result, you can erase that part of the trace and try again.

The strokes you draw don't have to cover the whole of the waveform, because the program will fill any gaps using linear interpolation. So if your waveform has straight-line segments (vertical, horizontal or sloping), just leave them out and the program will generate them for you. As an example, if you want to create a sawtooth waveform, all you need to draw is one very short line at the peak.

Drawing strokes are allowed to overlap each other. Where they do, the program will take an average for the sample value.

6 Editing the Trace

It's hard to trace a waveform accurately in one attempt, so there's an 'Erase' drawing mode, selected by the radiobutton at the bottom of the window. In this mode, the cursor changes to a vertical arrow.

To erase a section of the trace, position the mouse at one end of the section to be erased, and drag horizontally to the other end of the section. When you press the mouse, a vertical line appears on the canvas as a marker. As you drag, a second vertical line follows the mouse. When you release the mouse, whatever is between the lines will be erased.

There's no 'Undo' functionality, so if you accidentally erase too much you have to redraw it. For a program as simple as this, I didn't think the ability to undo actions was worth the effort. If you think otherwise, let me know why it's a problem and I'll see what I can do.

7 Short Cuts

7.1 Mode Switching

When tidying up a trace, you'll probably be switching frequently between the Draw and Erase modes. For convenience, there are a couple of short cuts to reduce the mouse travel:

- If you click the middle mouse button anywhere within the drawing area, the drawing mode will toggle between Draw and Erase. If the mode was one of the other modes (Adjust Axis or See Result), Draw mode will be selected. In case your mouse doesn't have a middle button, holding down the shift key while clicking in the drawing area will have the same effect.
- If you right-click anywhere in the drawing area, you'll get a popup menu allowing you to select any drawing mode. This menu duplicates the function of the radiobuttons. In case your mouse doesn't have a right button, holding down the control key while clicking in the drawing area will have the same effect.

7.2 Zooming

When you alter the zoom factor from the Zoom menu, the program tries to keep the point at the centre of the screen in the same place after the zoom. If you start at zoom factor 1

(say) and switch to zoom 8, this means you'll probably have to scroll around afterwards to find the detail you were looking for.

An alternative method is to right-click (or control-click) to get the popup menu described above. The Zoom menu is repeated as a sub-menu in the popup, and when you select a new zoom factor from it the original point where you clicked the mouse will then be centred in the screen. This is a much easier way to display the detail you wanted to see.

8 Viewing and Trimming the Result

After tracing the waveform, select the 'See Result' drawing mode. This overlays the waveform with a histogram (in blue by default, but you can select a different colour from the Options menu). In this mode, the cursor changes to a small cross. The histogram has 256 segments and indicates the sample values calculated from the trace. If your waveform has sharp edges or other detail features, you can now clean them up by dragging individual samples up and down on the screen. You will almost certainly want to select a highish zoom factor for this – otherwise the sample lines will be too small to work with. The Options menu also has an entry for adjusting the thickness of the histogram lines. The selected thickness applies to the horizontal sample lines only – the vertical lines joining them are always one pixel wide.

After displaying the histogram, you can still go back and edit the trace or adjust the axis. However, after making any such changes the histogram will need to be regenerated, which will lose any tweaks you may have made to it. So the adjustment of individual samples does need to be the last task before saving the file.

At the bottom right of the window is a 'Hide Picture' button which does what it says. The button may be useful at this stage, in order to see a clearer view of the histogram.

8.1 The Cycle Transition

You'll probably want to make sure that the end of the cycle makes a smooth transition to the start of the next cycle. For this, turn on the 'Extend Histogram' item in the Options menu. This extends the histogram display by 20 samples at each end. At the start, the 20 samples are copied from the end of the waveform, and at the end the extra 20 samples are copied from the start. Thus, you can view the transition at either end. If it isn't smooth, you can drag individual samples to adjust it or, probably easier, you can go back and edit the trace line until the transition is acceptable. If you are going to edit the trace, be sure to do it before any edge cleanup. Otherwise, you'll lose the edge cleanup when the histogram is regenerated after the trace edit.

8.2 Edges

The very last task before saving the file is to clean up any sharp edges that you may want in the waveform. It's easier to do this by dragging individual samples than by editing the trace line.

9 Controlling the Clutter

By the time you get to the final stage of cleaning up the histogram, you'll find that it's difficult to focus on the superimposed images of the background picture, the trace strokes you've drawn, and the histogram itself. They are, after all, all competing within the same screen space.

The program tries to help in three ways:

- Whenever you select the ‘Draw’ or ‘See Result’ drawing modes, the trace or the histogram respectively will be brought to the foreground. Use this when you want to concentrate on one or the other.
- The Options menu lets you adjust line colours and thicknesses. This gives you a way of emphasizing what you currently want to examine, and providing contrast against other components of the display.
- The ‘Hide Picture’ button lets you suppress the background picture when you want to concentrate on the other items.

10 Saving the Result

When the histogram is to your liking, it’s time to write the data file. The ‘Save Data’ entry in the File menu will bring up a dialog box to allow you to name the file, and the save is then done without further effort.

There is, however, one option you will probably want to consider before saving. The File menu also contains a checkable item labelled ‘Remove DC on Save’, which affects the way your data file will be written.

If you save the data without checking the menu item, the waveform will be scaled so that it uses the full range of sample values (0–255). If the waveform is asymmetric, that will generally imply that it has a constant DC offset to some extent. If you would like to remove the DC offset, select the menu item before saving. The average level of the saved waveform will then be 0V. It won’t use the full range of sample values, but it will use as wide a range as possible.

11 Help Menu

If you’re reading this, then either you’ve figured out the Help menu³ or you’ve otherwise found and opened the `manual.pdf` file, because that file is what you’re reading now.

There are two items in the Help menu. The first is the command to display the manual, and the second just tells you the version number of the program. The version number item doesn’t have any action associated with it, which is why it’s permanently greyed out.

If the help menu gave you a strange error message, then here’s some detail on what was supposed to happen.

When the wavemaker program starts up, it looks in the directory containing the script `wavemaker.tcl`, and expects to find this PDF manual as the file `manual.pdf`. If it doesn’t find the file, the entry in the Help menu will bring up a dialog box explaining that the file couldn’t be found.

If the file is found, then the entry in the Help menu is supposed to open and display the manual using whatever application is appropriate for the operating system under which the program is being run. The method of opening the file varies depending on your operating system:

Linux or Mac: The program looks for the presence of a suitable application on the system, using a hard-coded list of possibilities. The first one on the list that it finds to be present on the system will be used. If none of the applications on the list is present, the menu item will bring up a dialog box explaining that an application couldn’t be found.

Windows: The program uses the supplied `ShelExec.exe` application to find a suitable PDF viewer.

³Well, it was hardly rocket science...

Other: If the program didn't recognize your operating system as one of the above, the Help menu will display a message to that effect.

If you got an error message when you tried the Help menu, then please let me know. It would get a high priority on the bug list.

12 Bugs

12.1 Errors

Well, there aren't any, of course. But if you think you've found one, please do email me, describing the problem and quoting the program version number (given as the last item in the Help menu):

`john@jsjf.demon.co.uk`

If you ask nicely, I'll see what I can do...

12.2 Omissions

I decided not to implement the following potential features. If you think they should be done, I'm open to discussion...

- There's no 'Undo' feature. Once you've made an edit, you can only back it out by using the erase/draw cycle. Since it takes only about five minutes to do a complete waveform, I haven't seen this as a problem.
- There's no way to save an editing session and return to it later. The reason is the same as above: editing sessions just don't take long enough to make the feature necessary.