

# Schematics at Your Fingertips

If you can run *Microsoft Windows Paintbrush*, you can move those dog-eared schematics off the backs of envelopes and into your computer where they belong.

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**D**id you ever wish you could sit down at the computer and draw the schematic of that weekend gem you just completed at the workbench? You can—with one of those expensive drawing programs you've drooled over in the software ads. But those programs cost from around a hundred to thousands of dollars—quite an investment for a weekend engineer! In this article, I'll tell you how you can get started with basic schematic CAD (computer-aided design) on a budget. The secret is an application that comes bundled with *Microsoft Windows*.

## Windows?

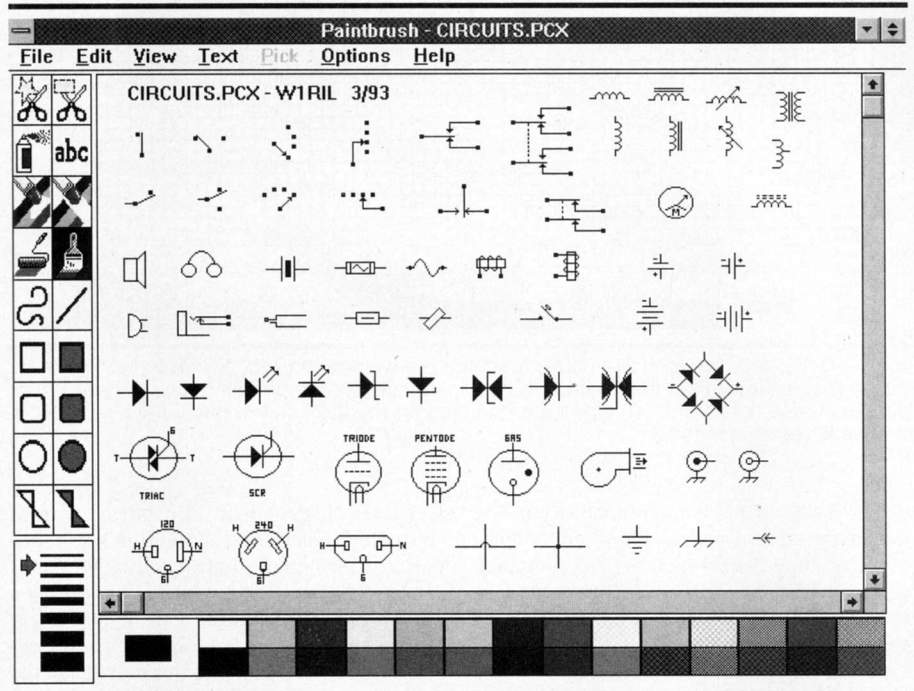
Many IBM-compatible PC systems come with a program called *Windows*, the latest version of which is 3.1. *Windows* is an operating environment: It manages the affairs of, and gives a consistent look and feel to, *Windows*-compatible programs—*applications*—that run within it. The *Windows* package comes with a set of basic applications that include ASCII text editing (*Microsoft Windows Notepad*), word processing (*Microsoft Windows Write*), calendar, calculator, telecommunication, drawing and game software. Drawing? Bingo! The *Microsoft Windows* bundle includes *Microsoft Windows Paintbrush*. *Paintbrush* allows you to draw on-screen in monochrome or color (if you're fortunate enough to have a color system). You can draw straight lines, boxes, circles, rectangles, triangles—you name it! You can even magnify (zoom in) on an area in the drawing and get right down to the picture-element (*pel*, a shortening of the older term *pixel*) level, adding, erasing or changing pieces of the drawing to meet your requirements.

## Pel by Pel

A pel is small—about the size of a speck of dust on your screen. But you don't need a magnifying glass to paint images pel by pel with *Paintbrush*. Fig 1, a resistor I drew with *Paintbrush*, shows an example of this. Darkened pels form the resistor symbol. Now that you've seen what a *Paintbrush*-drawn schematic symbol looks like, you're ready to draw one yourself. Here's how.

Start *Windows* and run *Paintbrush*. (If you haven't moved the *Paintbrush* program item from its default location, you'll find it in *Windows*' Accessories program group.)

Most of *Paintbrush*'s startup defaults—



Brush tool, white background and black foreground colors—are just what you need to start drawing schematics. (If you're already in *Paintbrush* and have changed these settings to something else, change them back now.) One, the View default (Zoom Out) *isn't* what we need, so change it to Zoom In via the View menu. This changes the cursor to a rectangle. Position the Zoom In rectangle where you want it—right in the middle of the drawing area is fine for now—and click the left button on your mouse. (A right click at this point drops you back to Zoom Out.) Choose the minimum-width line in the Linesize box.

Move the cursor to the pel you want to change and left-click the mouse. This colors the pel black—the foreground color currently in force. (Right-clicking sets the pel to the background color—currently, white. So you can use the right mouse button as a form of Undo if you darken the wrong pel.) Do this pel by pel until the image—let's say you're doing your own resistor—is finished. If you have a steady hand, you can hold down the left mouse button and drag the pointer through the pel blocks you want to blacken. (Likewise, you can right-click and drag through pels you want to whiten.) Selecting Zoom Out lets you see the image full-scale.

## Snip, Snip, Snip

What if your finished resistor isn't quite where you want it? No problem! With Zoom Out selected, click on the Scissors tool in the Toolbox. Position the crosshairs cursor at one corner of the drawing section you want to move. Left-click and drag the cursor around the image you want to copy. (The Pick tool does essentially the same thing except that where you left-click anchors an expandable box that you drag larger to enclose what you want to copy. You may find this more comfortable to use than the Scissors.) Unlick. The enclosing line is now a dashed box. Position the cursor inside the dashed box, and drag the resistor image to where you want it. Magic! You've moved the resistor to a new location. Now select the Paintbrush tool.

*Paintbrush* also lets you copy images. So if you need more than one resistor, you only have to draw one. Select the resistor you drew with the Scissors. Click on Copy in the Edit Menu. Then click on Paste. Magic! Another copy of the resistor appears in the upper left corner of the image area (anything already there won't be affected) ready to be dragged to its final destination. Once you've moved it where you want it, click on the Paintbrush tool and you're ready to keep drawing. Or

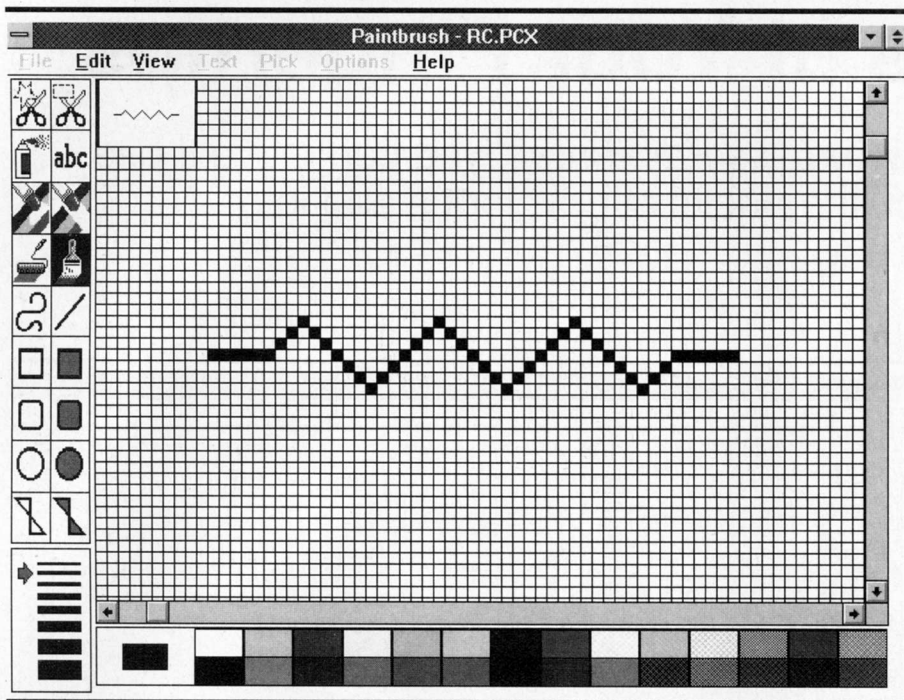


Fig 1—Darkened pels look like paint clogging up a window screen! *Microsoft Windows Paintbrush's* larger-than-life Zoom In view lets you draw components pel by pel with simple mouse commands. (It's possible to navigate *Paintbrush* with just a keyboard, but a mouse is recommended.)

choose Paste again to import another copy of the image. The Cut and Copy commands move or copy the selected pels to computer memory *Windows* calls the Clipboard. The image stays there until you overwrite it with something else or exit *Windows*. (You can view the Clipboard contents whenever you want by opening *Windows Clipboard Viewer* through *Windows Program Manager*.)

Once you've got two or more symbols where you want them, you can interconnect them with solid lines. You also can draw boxes, curves, circles and slanted lines—check out the Toolbox. You can even enter and edit text for drawing labels. I won't go into the details; the idea is to run *Paintbrush*, refer to its documentation (on-line Help and the *Windows* manual) as necessary, and *play!*

### Working Within *Paintbrush's* Limitations

With full-blown CAD packages, you don't need to draw most of the symbols you need. *Symbol libraries*—files containing predrawn components—account for part of their purchase price. You just import symbols from the symbol libraries as you need them. You can usually *scale*—resize—and rotate images until they appear as you want them. And big-time schematic CAD packages often contain PC-board drafting capability that can be linked to their schematic-drawing functions.

*Paintbrush* approximates *some* of this utility. There's currently no way to use a *Paintbrush* schematic file in generating PC-board artwork from *Paintbrush*, for instance. On the other hand, you can scale *Paintbrush* images via the Pick menu's Shrink & Grow command. You can flip them upside down (Flip

Vertical) or turn them into mirror images (Flip Horizontal). One limitation that's important in schematic drafting is that you can't rotate *Paintbrush* images 90°! *Paintbrush's* ability to import images can help you get around these limitations. The key is to develop symbol-library files that contain all the components you need in horizontal and vertical formats. Then you use Copy and Paste to move the images you want to and from the *Windows* Clipboard.

*Windows* itself lets you end-run another *Paintbrush* limitation that might complicate this process. *Paintbrush* can open only one image file at a time, so it might seem that you'd have to endlessly open, change, save and close files to make maximum use of the Clipboard. But since *Windows* lets you run more than one *Paintbrush* session at the same time, all you have to do is start and run

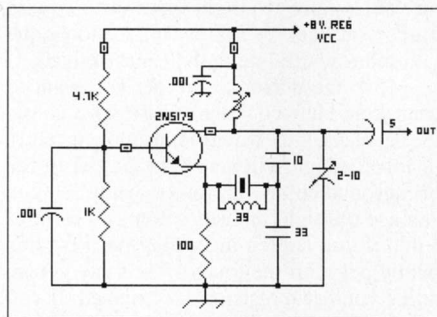


Fig 2—Drawing this VHF crystal oscillator is easy with symbol-library files in place. *Paintbrush* can't equal a full-blown CAD package, but it gives you enough functionality to get started in basic computer graphics.

as many *Paintbrush* sessions as you have symbol-library files, opening each additional file per each additional *Paintbrush* window. Then you can hop from session to session—in effect, from library file to library file—via *Windows' Task List* (callable by hitting **Ctrl-Esc**), or by **Alt-Tabbing** through them in turn.

### Ready-Made *Paintbrush* Symbol Library Files

I've saved the best news for last. Developing symbol libraries takes time—time you'd probably rather spend on drawing schematics than building basic components pel by pel. You can get the symbol library files I've developed from the ARRL telephone BBS or directly from me.<sup>1</sup> The files contain all the symbols I thought would be useful in making electronic schematics, including transistors and logic symbols. Most of the symbols are identical to those found in the *ARRL Handbook*. The files are named as follows:

ANTSYS.PCX	Antennas and dummy antennas, RF bodies and switches
RC.PCX	resistors and capacitors
CIRCUITS.PCX	tubes, diodes, chokes, switches, relays
TRANSLOG.PCX	transistors and logic symbols

The title graphic shows some of the symbols as they appear in *Paintbrush*. If the files don't contain a symbol that you need, you can draw it and add it to the library file or files of your choice. And of course you can customize my symbols as you wish. I encourage you to share your symbol-library developments with others via the ARRL BBS.

### Putting It All Together

Fig 2 shows a schematic of a popular VHF crystal oscillator circuit assembled from components in my symbol-library files. Going back and forth between drawing and symbol-library windows can be time-consuming. You can speed the process by predetermining which symbols, and how many of each, you'll need for a given drawing. Then you can repeatedly Copy (dragging each imported symbol out of the upper left drawing corner each time) as many times as necessary before moving on to the next symbol and overwriting the previous symbol on the Clipboard.

Once you've brought in all the schematic pieces and wired them together, you can save your weekend project's schematic for posterity as a new .PCX file. If you own a *Windows*-compatible printer, you can also print a paper copy for your records. *Paintbrush* allows you to resize the drawing when printing.

Now there's no excuse for not keeping your schematic records up to date!

<sup>1</sup>The ARRL telephone BBS awaits you at 203-666-0578. Copies of the symbol-library files are also available by mail from the author. Include with your request an IBM-compatible-formatted diskette (1.2-Mb [5¼-inch]; or 720-kB or 1.44-Mb [3½-inch]) in a suitable disk mailer (return postage required). **QST**