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A simple all-valve 1-inch oscilloscope by Ian Wilson K3IMW and Hans Summers G0UPL

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This oscilloscope uses a 1-inch diameter Mullard DH3-91 CRT. Some nice pictures of the DH3-91 are here . I found it at a car boot sale, priced £1. I'm ashamed to say I didn't recognise what it was: I only bought it because it looked wierd and interesting! Ian did the main design and prototype work on the 'scope, then I rebuilt it with a PSU and front panel controls, and packaged it nicely.
Click here to read about Ian's prototype
. The size of this oscilloscope is 164 x 83 x 83mm (6.5 x 3.25 x 3.25 inches).

I had some idea when I started building this oscilloscope, that I would build it in the stlye of a front panel instrument, which could later be bolted into the front panel of a large ATU / Power meter / Dummy load, and used as a monitor 'scope. I have not measured the bandwidth of the 'scope but I think it is safe to assume that it will be a lot more use at audio frequencies than VHF. Really it's more of a toy than a serious measurement instrument, nevertheless I think it would be useful as a monitor 'scope.

Circuit Diagram

This circuit diagram is mostly the work of Ian K3IMW. All I did was add the X/Y range switch and a

Click here to read a pdf document {gallery}tinyscope/3{/gallery}

Power Supply

The first thing needed was a power supply capable of providing +400V and -100V. I decided to get a cu

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I used the DuncanAmps PSU designer to help design and simulate the power supply (see image, above right). The custom transformer was manufactured for me by
Airlink Transformers
. Some fiddling with design parameters was necessary in order to keep the size and cost of the transformer as low as possible. In the end, I finalised on a voltage doubling rectifier design that would require a 200V input. The transformer from Airlink is rated for 111VA and has a standard UK mains 230V primary. The secondaries are 6.3V for the valve heaters, and 200V for the HT. The size is 45mm thick and 80mm diameter which determines the final size of the oscilloscope. The rectifier valves used are two EY70 subminiature, which are capable of handling the necessary voltages and currents. The 6.3V valve heater winding is not shown on the diagram.

The high voltage electrolytics were somewhat a problem. They are stacked on top side of /the chassis,

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Construction

Double-sided PCB was used for the chassis. There are four plates sized 80 x 80mm and one (the f

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I used a number of materials available locally from the DIY shop or model shop. Brass angle for

the internal frame holding the PCB plates (chassis, rear panel, front panel etc.) together. Steel mesh as side panels, to allow adequate ventilation. Aluminium angle to hold on the steel mesh side panels. The front panel CRT hood to shield it from ambient lighting, is made from 35mm outside diameter white plastic pipe from the DIY shop, spray painted black and affixed with superglue. This diagram (above right) should give some idea how the pieces go together.

Photographs

The photographs below and the associated text give more details of the construction. **Click the pictures for full size versions!**

Far left: valve placement. The EY70 subminiature rectifier valves are wire ended, the wires just pass through countersunk 1mm holes in the double-sided PCB chassis. The other valves are all socketed. The DH3-91 was initially not bolted in, until the correct angular orientation could be determined, to produce a correct horizontal trace.

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Various waveforms produced during construction, in which the Y-input was connected to the 6.3V 50Hz heater voltage supply.

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Far left: Fake front panel, it sits about 6mm behind the real front panel. All the rotary switches and potentiometers are bolted to this fake front panel. The real front panel (middle) has just the BNC input socket and on/off switch. These fit back through larger holes in the fake front panel. When assembled (right), the 1/8-inch switch and potentiometer shafts protrude through the front panel holes, such that the knobs can fit flush against the front panel. The CRT displays 6.3V 50Hz heater voltage still. This picture was taken before the CRT was rotated to get the trace horizontal.

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Notice in the background my HF Polyphase receiver monitoring 3.560MHz, the 80m QRP CW centre of activity. A square of green display filter is superglued to the inside of the front panel (middle). Right: this is how the fake front and real front panel assembly looked from behind, when all the switches and potentiometers etc were wired up. The Y-input resistor divider network is soldered next to the Y-range switch. Similarly the timebase capacitors are soldered next to the X-range switch.

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I built a Wien bridge test audio oscillator ugly-style on a piece of baked bean can tin plate, from a circuit found here at 4QD-TEC . It worked perfectly first time from a 12V supply and produces a nice sine wave with 6V peak-peak amplitude at about 1kHz. The light bulb I used is rated 6V 300mA. As expected, the setting of the preset resistor is quite critical to get a gain of three. Less stops oscillation, more distorts the sinewave. The circuit is shown on the right, Click it for full size view.

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Left: here's the finished chassis construction, with wires to the front panel controls neatly bundled and passing through a hole in the chassis. Middle: The frame construction is completed with four lengths of brass angle from the local model supplies shop, soldered lightly to the brackets on each panel. Right: the component side of the chassis. It looks a bit complicated in the picture but in real life it isn't so bad.

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The view from under the scope (left) shows the bundle of wires from the main chassis to front panel. There is plenty of slack so that the front panel assembly can be detached for further construction work and modifications. Poorly focused Wien bridge 1kHz sine wave at middle. The rear panel (right) has an auxiliary phono (RCA) input socket, which can be selected from the front panel instead of the front BNC input socket. This is for possible later use as a monitor scope. A hole drilled in the centre of the rear panel for the toroidal power transformer bolt saves about 5mm in the depth dimension of the scope!

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Front panel (left) is labelled with a marker pen for now. Later I might print something more professional looking! The CRT hood (middle) is made from a slice of 35mm o/d white plastic drainage pipe from the DIY store , spray painted black. The enclosure is completed by four panels of steel mesh (available in 50 x 25cm sheets from the
DIY store
). The panels are screwed onto the internal brass angle frame with screws through four lengths of aluminium angle, from the... you guessed it...
DIY store
. The steel mesh allows great amounts of heat to escape from the interior!

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Here are two pictures which try to convey the small size of this 'scope. Compare it to my usual HP1741A, and the size of my hand. While I'm here (and have got some spare space), I'll also tell you that the cabinet "feet" are in fact screw covers, which are available from the DIY store too. They make perfect feet, screwed onto the aluminium angle. Unlike the usual stick-on self-adhesive feet which you can buy, which have a rather limited lifetime before they will drop off.

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Further Work

The horizontal timebase needs some more work, since on some slower ranges the X width is slightly too small. Also there are some linearity problems which I have caused by reducing the timing resistor to timing capacitor ratio too much. The trigger circuit does work but not very excellently. It would be nice to make some improvements in this area. There is a spare front panel potentiometer which I think could usefully be made into a Y shift, if possible.

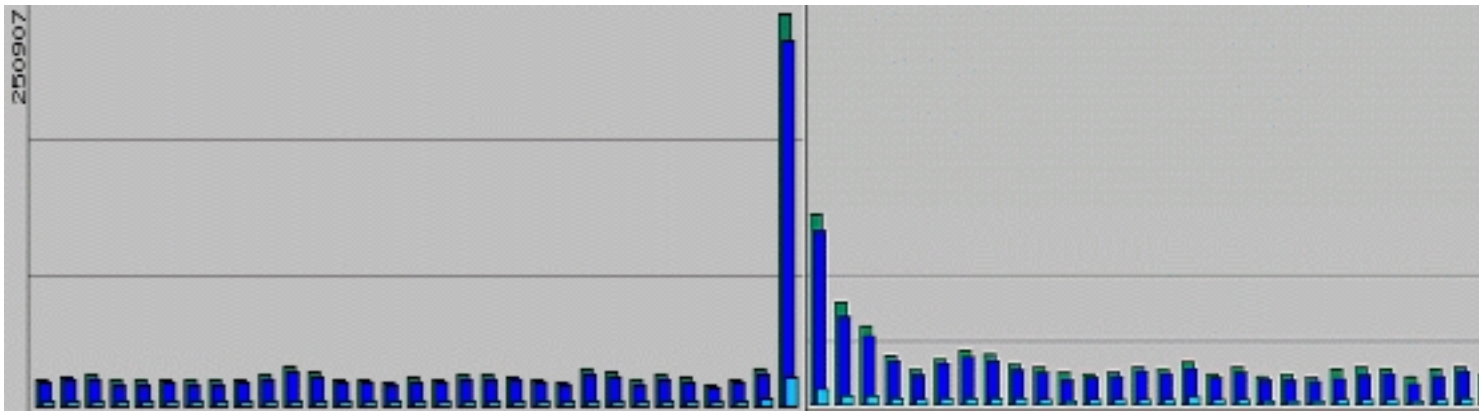
THANKS AGAIN to Ian K3IMW for all the help and components.

Further Reading...

Beautifully crafted miniature oscilloscope by Andy G4OEP, see photograph, right.
Click here to visit Andy's site.

FAME!

On 30'th July 2007, Hackaday featured my TinyScope project as their daily article. See their page here .
The feature caused a massive surge in hits on my website, as shown in the statistics chart below, which shows total website hits for July and August. August has been adjusted to be on a comparable scale to July.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