Construction Project:

PC-DRIVEN AUDIO SWEEP ANALYSER - 2

Here is the second of two articles describing our new PC-controlled audio signal and sweep analyser, based on the low cost DDS frequency synthesiser and ADC modules described in the September issue, and the dual power supply module described in the December issue. This month we look at the construction and setting-up of the analyser, which is capable of making measurements which compare very well with professional systems costing many times its modest outlay.

by TIBOR BECE and JIM ROWE

As you can see from the photos, the audio sweeper is housed in a plastic instrument case, of the same size as that used for the RF sweeper. And the construction is very similar, with the YADDS-1 and ADC modules mounted on a horizontal shield plate along with the power supply module (which is in this case the new dual supply module). This shield plate mounts in the bottom half of the case.

The additional generator 'output circuitry' and analyser 'front end' circuitry given in Figs.1 and 2 last month is all on a new PCB which mounts vertically in the front of the case, supported by the front panel switches. This makes the complete instrument quite easy to assemble and adjust. The IEC mains input connector is again mounted on the rear panel, along with the DB-25 plug used to connect the sweeper to the PC's printer port.

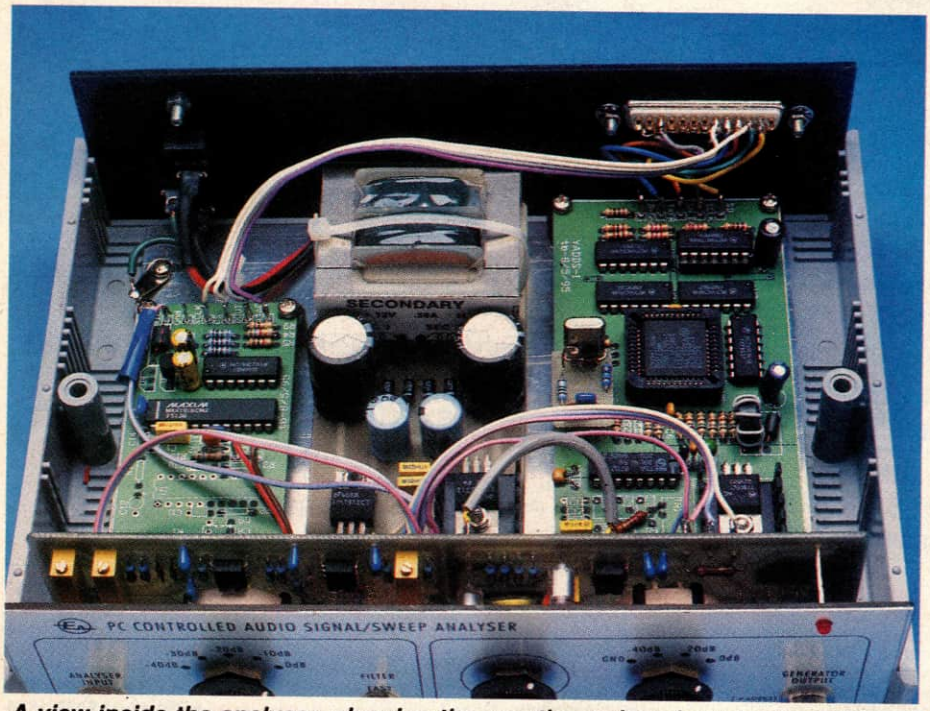
Assembly of the vertical PCB should be fairly straightforward, if you use the photographs and the overlay diagram of Fig.6 as a guide. The main things to watch are the orientation of the two rotary switches SW1 and SW3, op-amps U1-3, diodes D1-4 and solid tantalum capacitor C4. There are only two small wire links on the board — a short straight one between R22 and R27, and a bent one just below R27.

By the way, to facilitate making the various connections between this PCB and the YADDS-1, ADC and power supply boards more easily later on, it's a good idea to fit PCB terminal pins to the board.

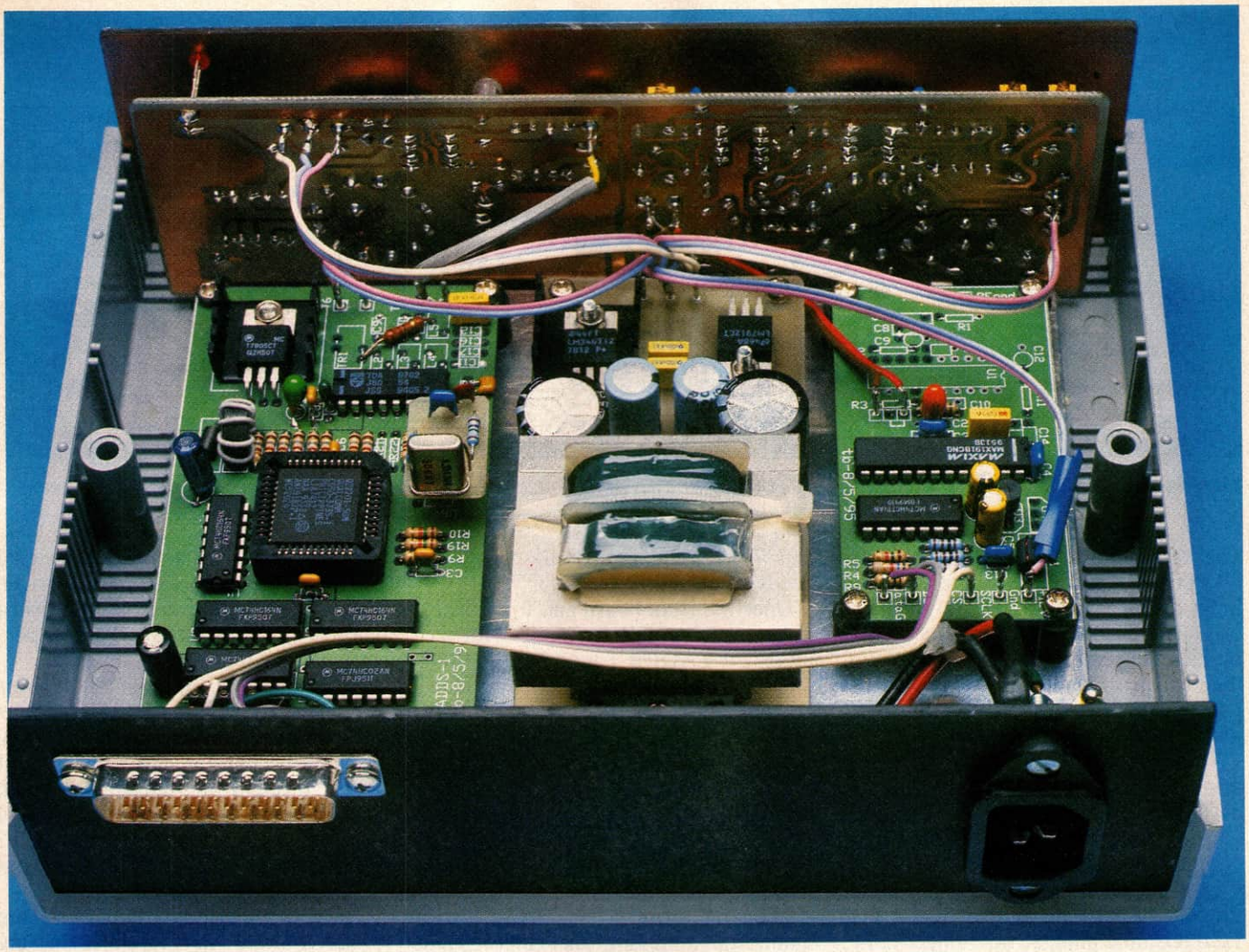
Fit two near R1 for the input to the generator output filter, three julust above R10 for the generator output circuitry supply connections, another three just below RV2 for the analyser supply connections, and finally two just below RV4 for the analyser front-end output connections to the ADC board. All of these pins should be fitted from the copper (rear) side of the board, because the connections are made on that side (see photos).

The reason for having two sets of supply connections to the PCB is that this helps keep generator signals from 'leaking through' into the analyser section. In fact if you look closely at the PCB pattern, you'll see that it's really two separate boards side by side, electrically isolated from one another.

Note that miniature toggle switch SW2 mounts directly on the PCB, with its mounting nuts and washers arranged so that it also helps support the board when it is attached to the front panel. However level pot RV1 mounts only on the front panel, with short lengths of tinned copper wire



A view inside the analyser, showing the way the various boards are arranged. The DDS and ADC boards are mounted horizontally on the shield plate, on either side of the power supply, while the vertical board used for input and output buffering is just behind the front panel.



Another view inside the analyser case, this time looking from the rear to show more detail of the connections between the various boards. Note that a piece of unetched copper laminate is used for the front panel, to provide shielding.

used to extend its three lugs back and mate with the corresponding PCB pads, when the board and panel are combined. The same technique is used for the two BNC connectors.

Apart from the pot and connectors, the only other component which is best NOT mounted initially on the PCB is the LED. It's easiest to leave this until the panel and board are combined, poking its body through the matching hole in the panel (from the rear) just before assembly, and then mating its leads with the PCB holes. Once the panel and PCB are combined the LED leads can then be soldered to the pads with the body neatly protruding from the panel, and then a small dob of glue added at the rear of the panel to hold it securely in place.

The BNC sockets used for the generator output and analyser input are mounted directly on the front panel, of course, again before the PCB and panel are combined.

Then short lengths of tinned copper wire can be used to make the connections to them. In each case, the earthy connection to the socket is also soldered directly to the copper of the unetched PCB laminate panel — which is used to replace the original plastic front panel of the case, as was done with the RF sweeper. The copper laminate is on the inside, so that it provides an earthed ground plane and shield. PCB laminate is easy to drill for the various control and connector holes, etc., and once everything is assembled is quite sturdy.

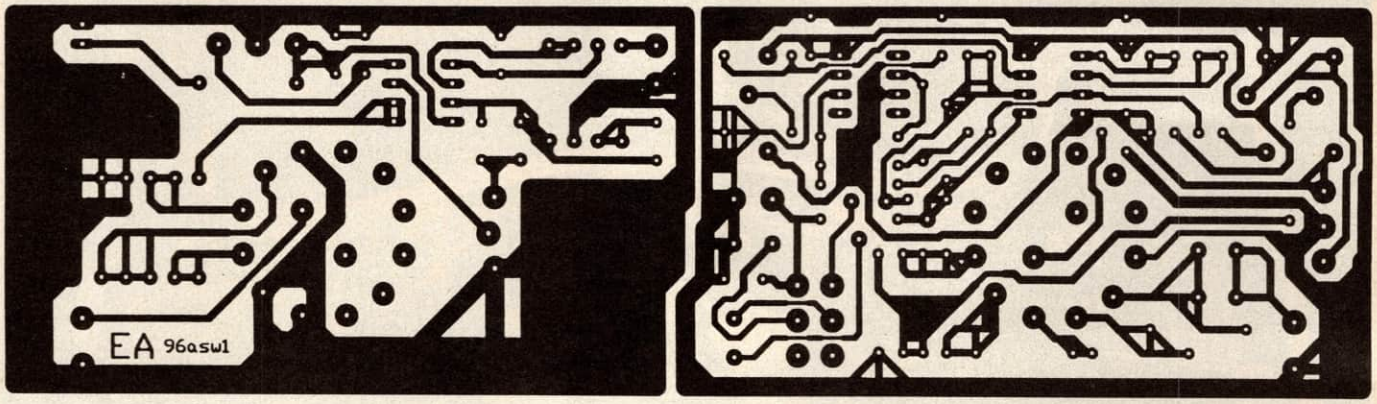
The PCB laminate front panel can be dressed up with an adhesive escutcheon plate made from Dynamark photosensitive aluminium sheet, to give the professional looking instrument shown in the photos. The artwork for the front panel is provided, along with that for the two PCBs.

Like the assembly of the front PCB, that of the little piggyback board for the replacement YADDS-1 module clock oscillator should be quite straightforward if you use the overlay diagrams as a guide.

Note that all of the passive components, including the crystal, go on the top, while U10 the SMD packaged IC mounts on the copper side.

Make sure you use a clean, fine tipped soldering iron to prevent making solder bridges when you solder the IC into circuit, and don't forget to leave both leads of C3, and also the end of R1 connecting to pin 12 of U10, at their full length so that they can be used to make the connections to the YADDS-1 module (and also support the clock PCB itself).

As well as assembling the clock PCB and fitting it to the top of the YADDS-1 module, you'll also need to fit the 220Ω resistor and 3.3nF capacitor to the module, for the first stage of the generator's output filter. They're shown at the left-hand end of Fig.1.



Here is the etching panel for the vertical PC board, shown actual size as usual for those who want to etch their own.

The capacitor is fitted in the original C13 position, while the resistor is fitted in a diagonal fashion, from the pad originally used to take the primary wire of TR1 connecting to pin 14 of U6, to that which took the pin of L5 which connected directly to C13 and the module's output pin.

There are really no modifications to make to the ADC module. It's simply assembled without the log detector chip U1 and all of its associated components (including regulator U4, R11, C12, R3 and C10). The original link at the end of R10 isn't fitted either, but PCB terminal pins are now fitted in the two outer pads of the three, to provide the new input terminals.

The assembly of the dual power supply module won't be described here, because it has already been described separately in the December issue. Note, however that for this project, you'll need to build it with the transformer and regulators to produce +/- 12V DC. In other words, with the 12V+12V transformer and the 7812 and 7912 regulators. Only the 7812 needs a heatsink.

Once the front board and front panel assembly is complete, along with the modified YADDS-1 module, the 'half empty' ADC module and the new dual power supply module, you're ready for the final assembly stage. Assuming, that is, that you've made up the horizontal shield plate and also fitted the DB-25 plug and IEC mains connector to the rear panel. If these are still not done, you may need to do them at this point.

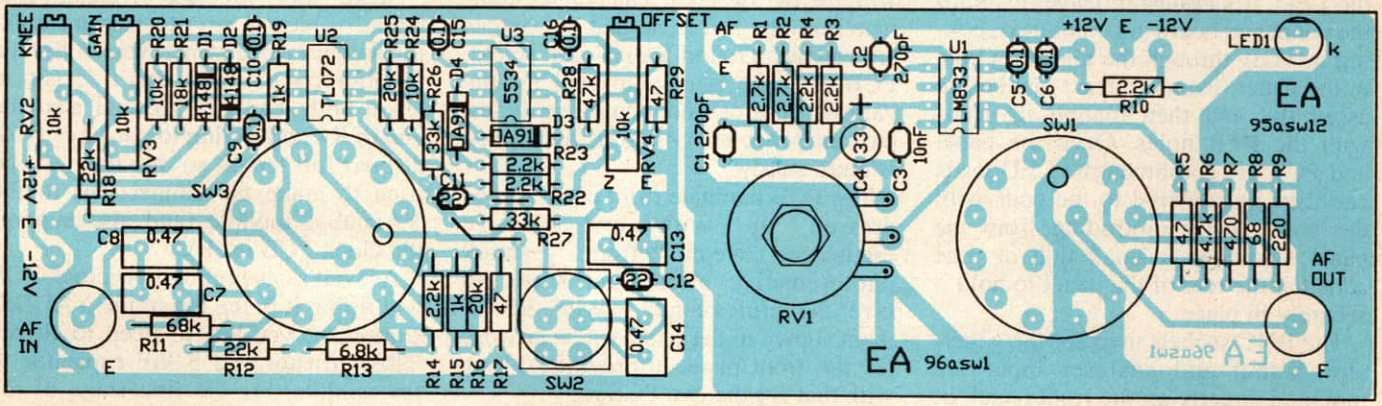
The final stage is essentially just a matter of mounting the three small modules to the shield plate, using 10mm long insulated and tapped spacers, then fitting the completed plate assembly into the bottom of the case, positioning the front and rear panel assemblies near their final positions, and connecting them together.

For most of these connections I used suitable lengths of colour coded light-duty hookup wire, taken from 'rainbow' ribbon cable; the only one I ran in shielded cable was the generator signal lead, from the YADDS-1 module to the input of the output filter on the vertical board, to ensure as little leakage as possible into the analyser section.

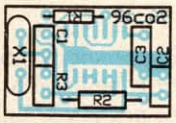
Note that there are quite a few wires to connect to the three DC output pins on the power supply module: three from the generator end of the front board, three from the analyser end, two from the YADDS-1 module and one (to the +12V) from the ADC module. This takes a bit of care, but can be done.

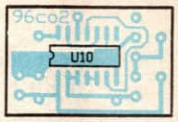
The connections between the YADDS-1 and ADC modules and the DB-25 connector are exactly the same as those used for the RF Sweeper, as described in the October issue on page 78.

Probably the only other off-board wiring that needs special mention are the connections to the IEC captive mains plug. These should all be made in wire with 240V AC rated insulation, and with the correct colour coding: green or yellow/green for the earth

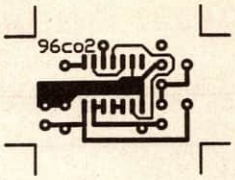


Use this overlay diagram as a guide to wiring up the vertical PC board. Note that the input and output sections of the board are kept electrically separate, and each has its own connections to the power supply.





These top and bottom overlay diagrams for the clock oscillator daughter board show where the leaded components go on the top, and the SMD chip goes on the bottom. Leads from C2 and R1 are used both to support the board and to make the connections to the DDS module.



And here is the etching pattern for the daughter board, again reproduced actual size so that you can etch one yourself if you wish.

lead, brown or red for the active and blue or black for the neutral. Active and neutral connect directly to the terminal block on the power supply module (outer screws), while earth connects to a solder lug attached to the horizontal shield plate.

Don't forget to fit heatshrink sleeving or varnished cambric sleeves over the active and neutral connections to the IEC plug, to prevent accidental shocks.

It's also wise to fit a couple of nylon cable ties to bind the active and neutral wires together, between the plug lugs and the power supply block. This ensures that if one wire should work loose, the other will tend to hold it away from the low-voltage wiring.

Setting it up

When your audio sweeper is fully assembled, check all of the connections between the boards, etc., to make sure everything seems in order (especially the supply connections). Then if all seems OK, try turning on the power and check with your DMM to ensure that the +12V and -12V lines measure correctly on the two halves of the front vertical PCB, as well as the +12V lines on the YADDS-1 and ADC modules.

All going well, connect the sweeper up to your PC's printer port, and run Tibor's DDS.EXE software — setting it for a clock or reference frequency (fr) of 4194.304kHz, and then keying in an output frequency (f) of 1kHz. You should now find that your sweeper's generator is producing a clean 1kHz sinewave, and with its level pot turned fully clockwise and its range switch set to the 0dB position, the output level should be around 1.1V RMS, or 3V p-p.

Now adjust the generator output level to exactly 1V RMS (2.83V p-p), as measured using a calibrated scope or audio millivoltmeter. You'll use this signal shortly, to calibrate the analyser section. Then press the computer's [ESC] key, to exit from the DDS.EXE program (which still leaves the generator running at 1kHz).

Turning now to the analyser, start Tibor's ADC.EXE program — which simply displays the ADC output in decimal form. At this stage you'll get a fairly random number displayed, as none of the preset pots on the vertical PCB is set correctly.

First of all, connect a BNC shorting plug or a 50Ω terminating plug to the analyser input socket, to ensure that there is definitely no AC input. Then if necessary adjust the 'Offset/Linearity' preset pot (RV4) for a reasonable reading, of around 150-200.

Now try adjusting the 'Knee' preset (RV2) one way or the other, to find which direction results in a lower reading. Then continue turning in that direction, and you should reach a definite 'null' or minimum reading. (If the

PARTS LIST

Vertical PCB:

Resistors

All 1/4W 5%, unless specified:

R1,2	2.7k 1% metal film
R3,4,10	2.2k
R5,17,29	47 ohms
R6	4.7k 1% metal film
R7	470 ohms 1% metal film
R8	68 ohms 1% metal film
R9	220 ohms 1% metal film
R11	68k 1% metal film
R12	22k 1% metal film
R13	6.8k 1% metal film
R14,22,23	2.2k 1% metal film
R15	1k 1% metal film
R16,25	20k 1% metal film
R18	22k
R19	1k
R20,24	10k 1% metal film
R21	18k 1% metal film
R26	33k 1% metal film
R27	33k
R28	47k
RV1	10k linear pot
RV2,3,4	10k linear trimpot, 10-turn

Capacitors

C1,2	270pF polystyrene
C3	10nF 100VW MKT
C4	33uF 16VW solid tantalum
C5,6,9,10,15,16	0.1uF 100VW MKT
C7,8,13,14	0.47uF 100VW MKT
C11,12	22nF 100VW MKT

Semiconductors

D1,2	1N4148, 1N914 etc
D3,4	1N60, OA91 or similar
U1	LM833 dual low noise op-amp
U2	TL072 dual FET input op-amp
U3	5534 high speed op-amp
LED1	3mm red LED

Miscellaneous

SW1,3	Single pole 4 pos rotary switch
SW2	DPDT miniature toggle switch
PCB	179 x 51mm, code 96asw1
	10 x PCB terminal pins, tinned copper wire, etc.

Clock PCB:

U10	74HC04 (SMD package)
R1	1/4W resistor (see text)
R2	1M 1/4W 5% resistor
R3	680 ohm 1/4W 5% resistor
C1	68pF NPO ceramic capacitor
C2	47pF NPO ceramic capacitor
C3	0.1uF monolithic capacitor
X1	4.194304MHz crystal

Case, etc:

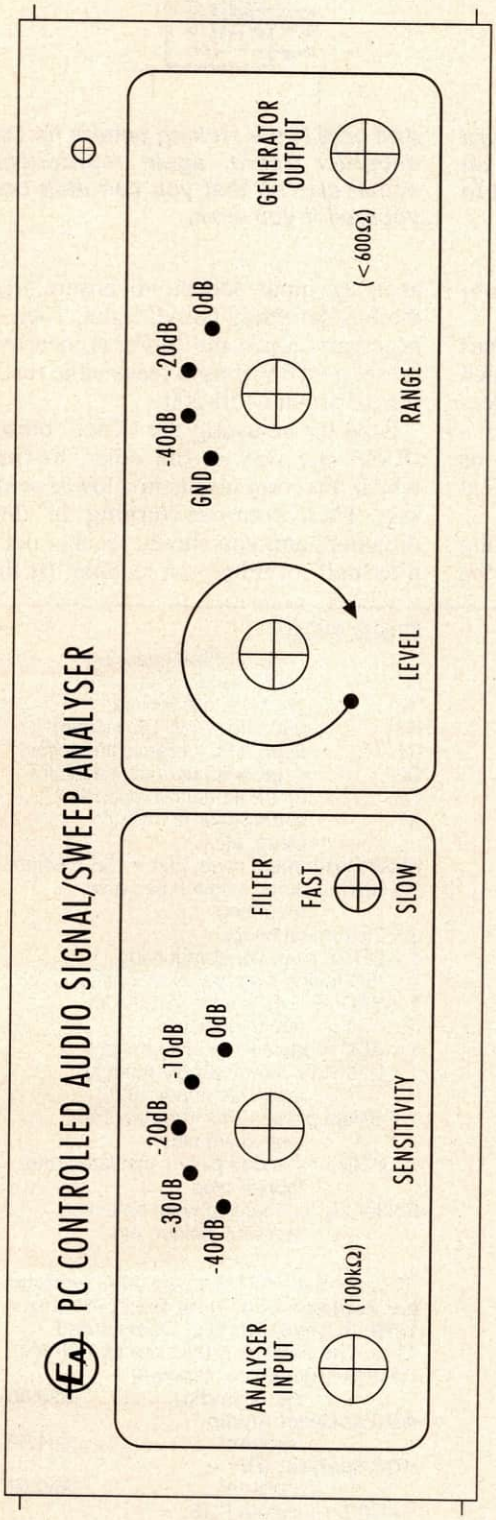
Plastic instrument case, 204 x 158 x 64mm
2 x BNC sockets, single hole panel mounting
3 x Instrument knobs
1 x DB-25 plug, panel mounting
1 x IEC mains plug, panel mounting
1 x YADDS-1 generator module kit, audio version*
1 x ADC module kit, audio version*
1 x Dual 12V power supply module (see December 1995)
1 x Shield plate, 170 x 120mm (1mm aluminium plate)
12 x 10mm standoff pillars, insulated and tapped type
Solder lug, connecting wire, heatsink sleeving, solder, etc.

***Kits for the YADDS-1 and ADC modules are available from Tibor Bece, PO Box 1379, Sunnybank Hills, Queensland 4109. The current prices are as follows:**

YADDS-1 generator (specify RF or audio) $99.00
ADC analyser (audio version) $64.00
ADC analyser (RF version) $69.00
YADDS-1 module PCB only $25.00
ADC module PCB only $20.00
Please add $5.00 for packaging and postage within Australia.

Mr Bece can now also supply Version 3.02B of his SWEEPER.EXE software on disk, for $49.00 plus $5.00 P&P if purchased separately, or $20 if purchased with the module kits.

PC-driven Audio Sweep Analyser - 2



Here is the artwork for the analyser front panel, again reproduced actual size to allow photocopying or production of a Dynamark stick-on panel.

reading drops to either zero or a very low level before the null is reached, adjust RV4 to increase the reading again.) The null will be quite sharp, and the idea is to set RV2 exactly at the centre of the null.

With that done, readjust RV4 again so that you're getting a quite low reading — it doesn't have to be zero, just below 20 or so. Then remove the shorting plug from the analyser input, and instead connect a cable between the input and the generator output. Since the generator should still be producing a 1V RMS signal, this will now be fed into the analyser.

Now adjust the 'Gain' preset pot RV3, until you get a reading of 3000. This corresponds to 3V DC at the input to the ADC chip — we set the analyser to produce this level at the ADC for an input level of 1V RMS, so as to give some safe 'headroom' above this reference level (0dBV). As the 'end stop' for the ADC is a DC level of 4.096V, setting the front end gain to produce 3V DC from 1V RMS input gives the analyser the ability to operate linearly to 1.36V RMS, or +2.67dBV. This should be more than adequate for most audio response testing using 1V as the reference.

With RV3 set for a reading of 3000, turn the generator range switch (SW1) down to the -40dB position, to reduce the generator output to 10mV RMS. Now you can adjust the 'Offset/Linearity' preset pot (RV4), to give a reading of 30.

As the gain and offset adjustments are interdependent, it's then a good idea to return the generator range switch to the 0dB setting, and check that the analyser reading returns to 3000. If it doesn't, adjust Gain pot RV3 again until it does; then switch back to the -40dB position and if necessary, tweak RV4 again for a reading of 30. You may have to repeat this process a couple of times, to get the settings correct.

As a final check, try setting the generator switch to the -20dB position. The analyser should give a reading of 300, or very close to it, if everything is set correctly.

Your audio sweep analyser should now be ready for operation. Tibor's DDS.EXE program can be used to set the generator to any desired single frequency, while his LEVEL.EXE program can be used to give analyser level readings directly in dBV (call it by typing '**level lin_adc**', and then pressing [Enter]).

DDS.EXE, ADC.EXE, LEVEL.EXE and other handy drivers are available via the EA Computer BBS, in the compressed file **YADDSDRV.ZIP**. If you can't access the BBS, we can supply the files if you send us a formatted floppy disk and $5 to cover P&P.

Of course for sweeping, Tibor's SWEEPER.EXE program is just the shot. It's very easy to use, very flexible and now has extra facilities like the ability to save screen grabs to disk in .BMP format (to import into DTP packages, print from Windows, etc.), and the ability to save up to eight sweep plots to disk, for later recalling and comparison. You can also set it for logarithmic sweeping instead of linear, and for up to five decades of frequency.

For audio sweeping you call the program by typing '**sweeper audio**', before pressing [Enter]. The 'audio' parameter tells the program to use the correct configuration file (AUDIO.SET), which sets everything up with your last settings for audio sweeping. Once the program fires up, pressing [h] displays the on-screen command menu, and after that everything is fairly intuitive.

The latest version of SWEEPER.EXE is available from Tibor for only $20, if purchased with the modules, or $49 plus $5 P&P if purchased separately. I can warmly commend it, as I've been using it for a while now. It really makes audio sweep analysis a pleasure.

So there you have it — a very neat and professional PC-driven audio sweep analyser, easy to use and capable of making measurements which compare very well with those from equipment costing many thousands of dollars. ❖