Playmaster Stereo Graphic Analyser

Functions as a room analyser or peak level meter with 20 LED display

While graphic equalisers have considerable potential to improve the sound quality of any high fidelity system, they are difficult, if not impossible, to use without supporting equipment such as a graphic analyser. Our new Playmaster Graphic Analyser is the perfect complement to our recent Playmaster stereo graphic equaliser or any commerical equaliser.

by RON de JONG & LEO SIMPSON

When we published our highly successful Playmaster graphic equaliser back in May 1979, we indicated that we would follow it with a companion analyser. We have always been of the opinion that graphic equalisers are merely a source of frustration and confusion for keen audiophiles, unless they have access to a suitable analyser. Now, after some delay, we present the Playmaster Graphic Analyser.

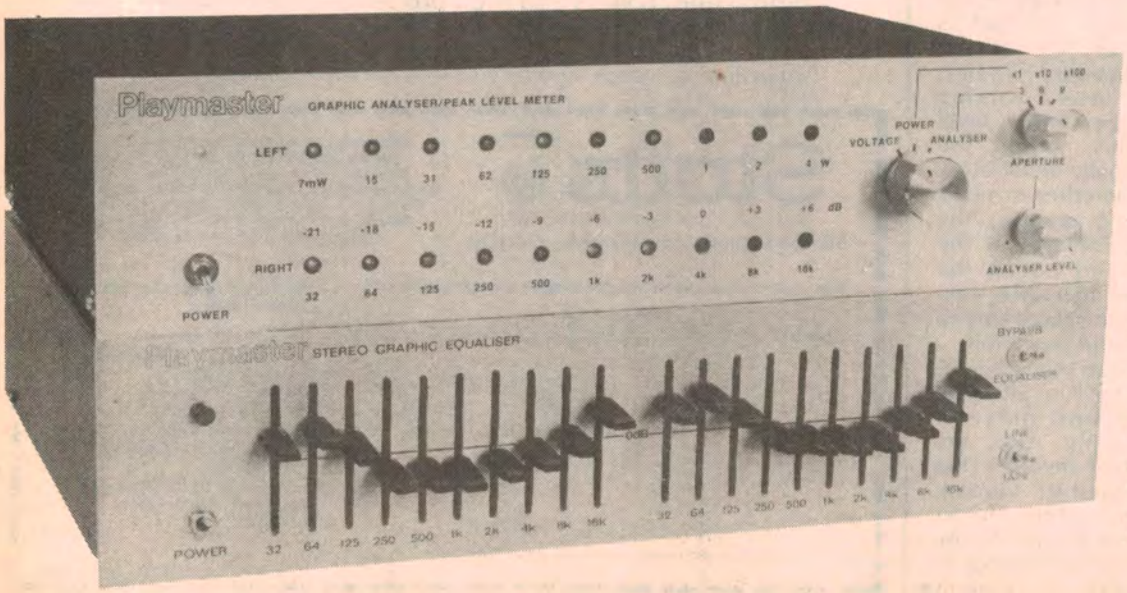
Our new Playmaster Graphic Analyser provides a visual display of frequency response; as with the Playmaster graphic equaliser and the better commercial graphic equalisers it divides the audio spectrum into ten octave bands with the same centre frequencies, ie. 64, 125, 250, 500, 1k, 2k, 4k, 8k and 16kHz.

Each octave band has a vertical display consisting of two LEDs. If the amplitude of the input signal within one of these frequency bands exceeds a certain limit the lower LED for that band will turn on; if the amplitude increases further, the top LED in the band will turn on as well.

The difference in signal level between the top and bottom LEDs in a band is set by what is termed the "aperture" control. We have provided three aperture settings: 3dB, 6dB and 9dB. The idea of having two LEDs per octave band is to display the frequency response within narrow limits, as defined by the aperture control.

When equalisation is performed with a graphic equaliser and our companion analyser, a pink noise signal is fed to the amplifier and speakers. The signal is monitored by a microphone and then displayed on the graphic analyser. The equaliser slider controls are then adjusted to obtain an optimum flat frequency response as displayed by the two LEDs in each octave band.

Pink noise is similar to white noise except that it is "pink", ie. the energy content decreases as the frequency increases. To define it more precisely,



Teamed with our Playmaster Graphic Equaliser or just about any commercial equaliser, our new Playmaster Graphic Analyser enables loudspeaker systems and the rooms in which they are used to be accurately analysed. At other times, the Analyser functions a as dynamic display for power output or signal level.

pink noise is random noise with an equal energy distribution for each octave bandwidth. This means that it has the same energy content for the octave centred on 64Hz as it does for the octave centred on 16kHz, or any other frequency.

Normally, pink noise is produced by passing the signal from a white noise generator through a filter which rolls off the high frequency response at the rate of 3dB/octave. The inbuilt pink noise generator in our analyser is provided in the same way. A preamplifier is also incorporated to enable a microphone to be connected.

With pink noise fed through a system, flat frequency response is indicated when only the bottom row of LEDs in the front panel display are on. If the aperture control was set to 3dB then this would mean that the frequency response between bands was equalised within at least 3dB. Aperture settings of 6dB and 9dB would likewise imply equalisation to within 6dB and 9dB respectively.

Naturally, when you begin to equalise your system, the overall frequency response of the system/room combination will probably be anything but flat and so not all the LEDs on the analyser panel will be alight. You may have to first make some changes in the positions of loudspeakers and perhaps the positions of some pieces of furniture. A guide to this process is given in our article entitled "Locating Peaks and Troughs with an Equalisation Analyser" published in the February 1978 issue of "Electronics Australia".

Assuming that this initial procedure has been carried out, then adjustment of the equaliser controls can begin. The level of the pink noise signal is adjusted so that it is high enough to mask out any ambient noise in the system or room. Then the analyser level (sensitivity) control is adjusted so that about half the LEDs are alight.

Now if both LEDs for a particular octave band are both out, then the response for this band is too low. Similarly, if both LEDs for a particular band are alight, then the response for that band is too high. The slider controls on the graphic equaliser should then be adjusted accordingly.

Besides this most important function of system or room equalisation, our new Analyser provides a bonus. When not displaying room or system response, it can provide a dynamic horizontal "bar-graph" display of the signal levels in both channels of a stereo system. Thus, it may be used to monitor signal levels during tape recording or the power delivered by an amplifier.

When measuring power, the analyser can indicate powers up to 400 watts (referred to an 8-ohm load). When measuring signal level, the display may be calibrated to agree with 0VU of the tape recorder being used, by adjusting the rear-mounted "peak level" control.

In total, our new Playmaster Graphic Analyser/Peak Level Meter, to give it its full name, can be regarded as a real bargain. At around $95 in kit form it is a mere fraction of the cost of equivalent commercial equipment. It is also easy to build and uses readily available parts.

SPECIFICATIONS OF THE THREE FUNCTIONS

GRAPHIC ANALYSER

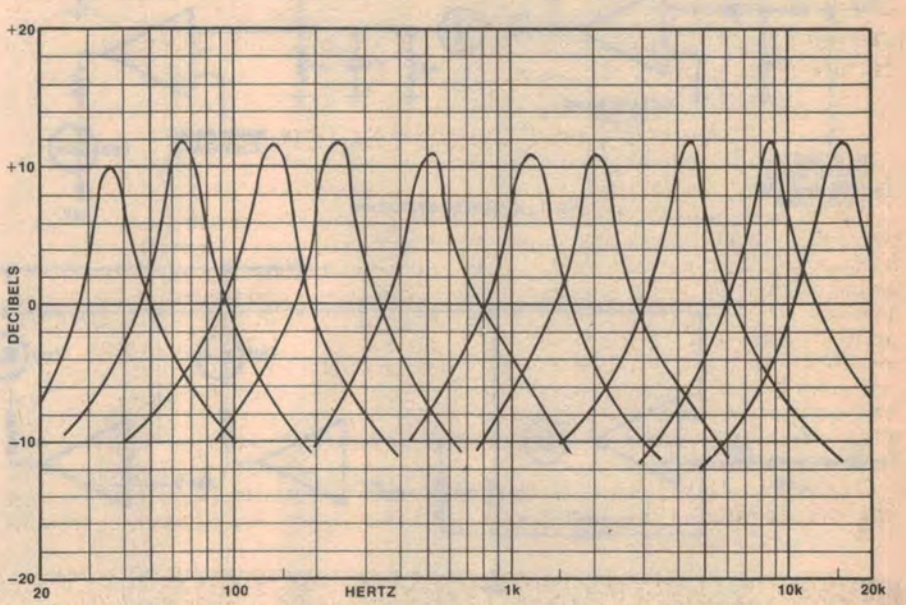
Display: 10 frequency bands, 2 LEDs per band
Centre frequencies of bands: 32, 64, 125, 250, 500, 1k, 2k 4k, 8k, 16kHz
Q factor of filters: 5
Aperture: 3dB, 6dB, 9dB
Line input sensitivity: 15mV RMS with 50k input impedance
Microphone input sensitivity: 80uV RMS with 10k input impedance
Averaging period: 4 seconds

PEAK LEVEL METER

Display: Left and right channels, 10 LEDs per channel
Scale: 3dB per step from -21dB to +6dB
Accuracy: ±0.5dB with respect to 0dB indication
Response decay time: 50ms
Line input sensitivity for 0dB indication: 75mV

PEAK POWER METER

Display: Left and right channels, 10 LEDs per channel
Scale: 7mW, 15, 31, 62, 125, 250, 500, 1W, 2, 4
Range: x1, x10, x100
Maximum power indication: 400 watts
Calibration: with respect to an 8 ohm load.



The shape of these filter curves in the Analyser complements the filters in our Playmaster graphic equaliser. Because of the shape of these filters it may be found that a high boost setting on one slider control will cause more than one Analyser LED to light.

CIRCUIT DESCRIPTION

The circuit of our Analyser is pretty daunting to look at, especially if you consider that nine op amps have not been shown, to simplify it. In all, there are 39 operational amplifiers in the circuit but these are actually in the form of uA4136 quad op amps, so the number of IC packages is relatively small. One op amp, IC 9d, is not used.

Beside the 39 op amps, there are two three-terminal regulator ICs and a noise generator IC, plus, incidentally, a lot of resistors and capacitors.

As can be seen on the upper half of the circuit diagram, there are two rows of LEDs, each driven by an op amp. The LEDs are depicted in rows in the same order as they appear on the analyser front panel. In the peak level meter mode, the top row of LEDs displays the signal in the left channel of the amplifier while the bottom row displays the signal from the right channel.

Whereas the peak level meter mode

results in a horizontal display, the analyser mode results in a vertical display, ie. ten columns with two LEDs each. This may seem complicated but it turns out to be quite easy to arrange the op amps to provide either mode quite simply.

The mode in which the display works is set by the function selector switch, S1. We shall discuss the analyser mode first.

Input signals to the analyser are fed from the Mic/Line switch S3 to op amp IC7c which is a non-inverting amplifier.

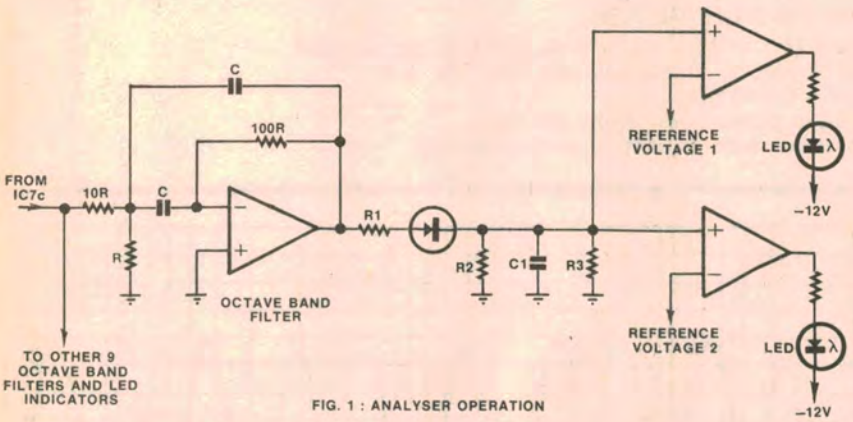


FIG. 1 : ANALYSER OPERATION

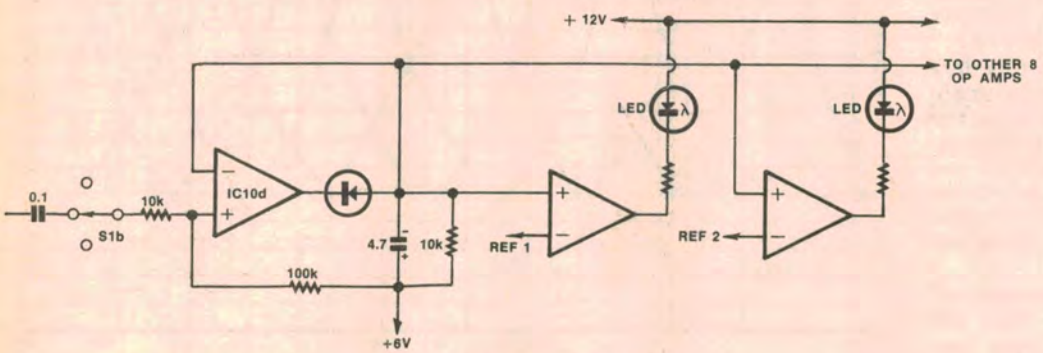


FIG. 2 : PEAK LEVEL METER OPERATION

IC7c drives ten octave-band-filters which correspond to the ten centre frequencies listed above. Each filter is followed by a half-wave rectifier and filter.

Each rectifier output is fed to a pair of op amps which are each connected as comparators and drive a LED. The comparators are referenced to one of two voltages to set their thresholds. The basic circuit concept is shown in Fig. 1. Later we shall explain the differences between Fig. 1 and the main circuit diagram.

Almost the entire circuit of the graphic analyser is reconfigured to provide the peak level metering mode. The basic circuit arrangement is shown in Fig. 2. This shows the circuit for the left channel display only.

IC10d operates a negative peak level detector which is referenced to +6V. If the input has a peak value of 150mV, for example, then the capacitor at the output of IC10d will be charged to 150mV below +6V. As a further example, if the input signal has a peak value of 4V then the capacitor at the output of IC10d will be charged to 4V below +6V, ie +2V.

Each of the 10 op amp comparators following IC10d has a reference input voltage which ranges from 100mV to 2.7V below +6V. If the input signal exceeds 100mV peak, then the first LED will be turned on. If the input signal exceeds 2.7V peak, then all LEDs will be turned on. The ten comparators thus provide a signal display range of close to 27dB total.

While the analyser and peak level functions depicted in Figs. 1 and 2 are both relatively simple in themselves, the whole circuit has to be virtually turned upside down to provide either function.

For example, while IC10d drives the non-inverting inputs of the ten comparators in the peak level mode, it (IC10d) is used to hold those comparator inputs at a fixed reference when in the analyser mode.

Notice also, that while IC10d drives the non-inverting inputs of its associated ten comparators, IC10c, for the left channel, drives the inverting inputs (not the non-inverting inputs) of its associated ten comparators. The latter set of comparators would not work in the correct "sense" were it not for the fact that their associated LEDs are driven from the -12V line rather than the +12V line.

For the same reason, there is a fundamental difference between the complete circuit and Fig. 1 in that the inputs to the lower comparator are reversed.

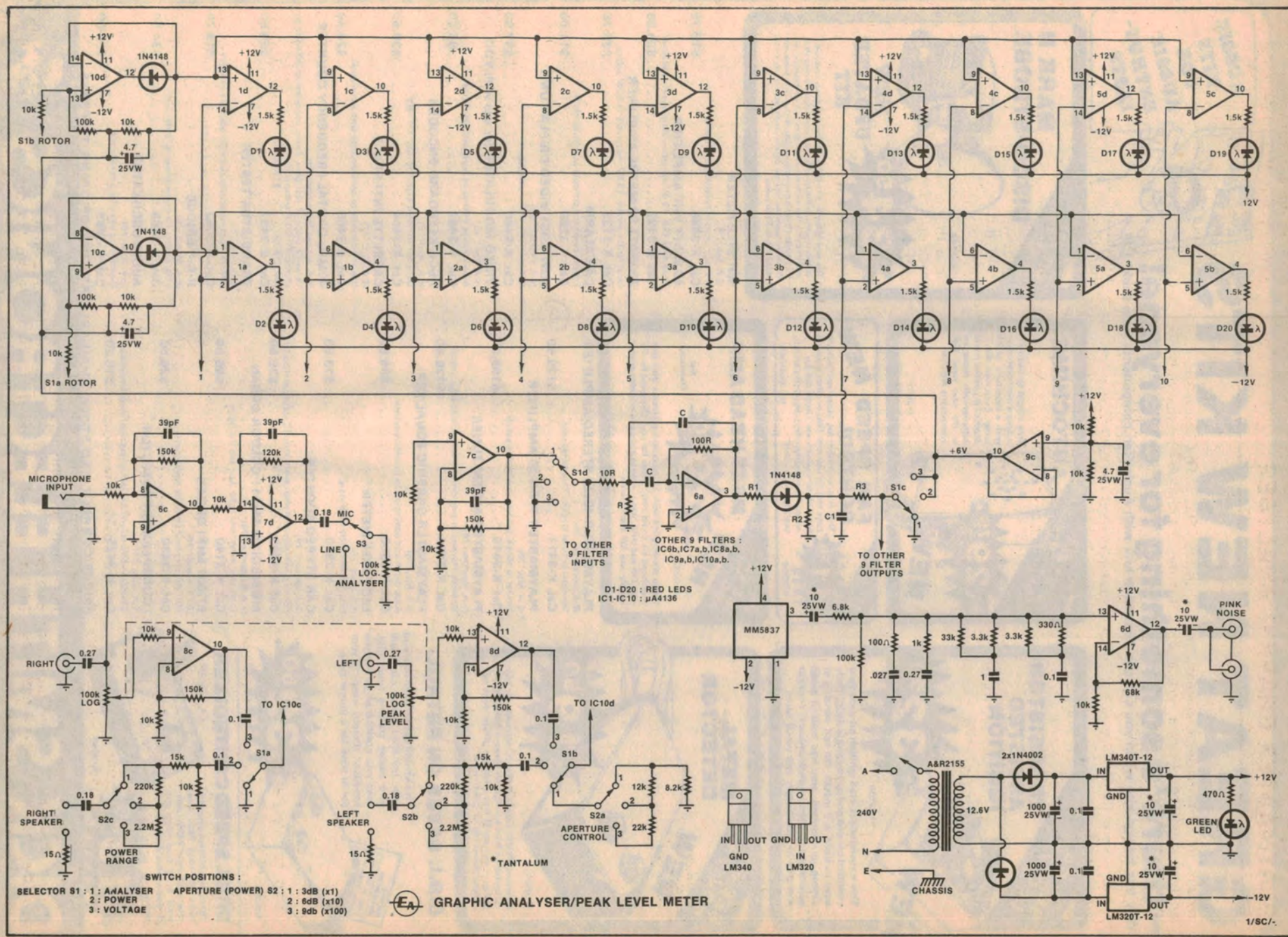
The need to drive the top set of LEDs from the positive 12V line while the lower set of LEDs is driven from the negative 12V line really has nothing to do with the operation of the circuit. It was done merely to simplify the layout of the printed circuit board.

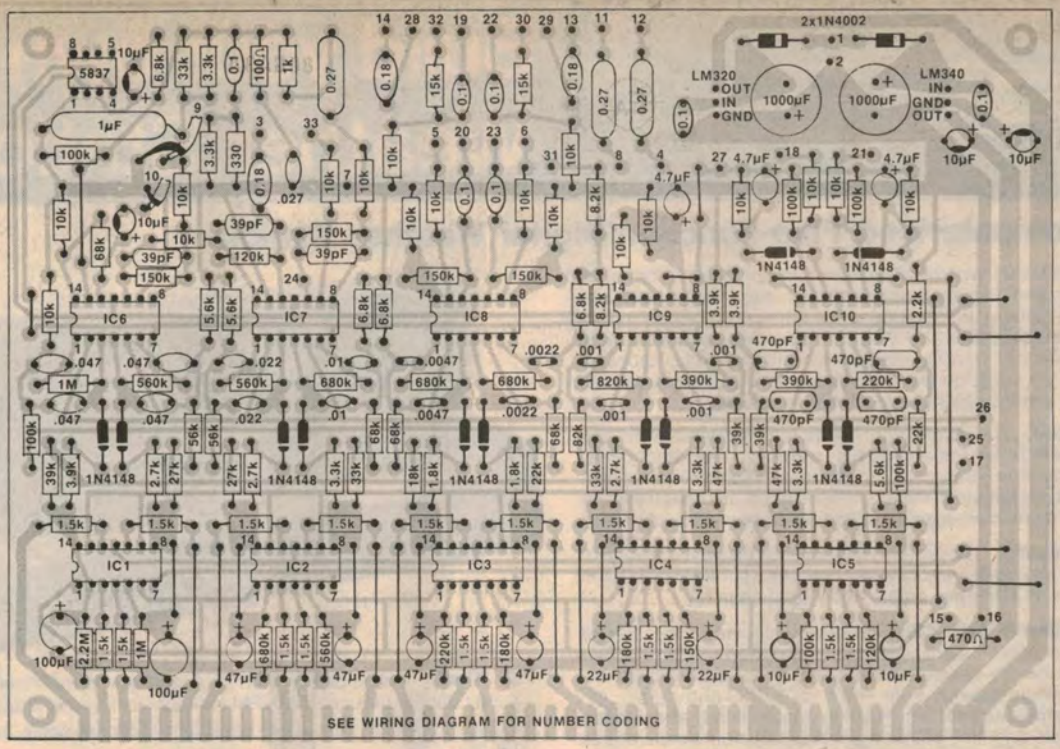
About the only major point left to be explained about the circuit operation is how the reference voltages for the two strings of ten comparators are provided. These are actually provided by voltage dividers made up from R2 and R3 on the output of each octave band filter. Since the octave band filters are not operating when in the peak level mode, their output is zero and so R2 and R3 can provide a fixed voltage reference from the +6V output from IC9c.

The pink noise generator is a standard circuit which we have published before. It uses a National Semiconductor IC, type MM5873. This generates white noise digitally, using a "pseudo-random bit sequence" (PRBS). The white noise is then passed through a filter network which provides a piecewise approximation to a 3dB/octave slope. The output of the filter is buffered and amplified by IC6d.

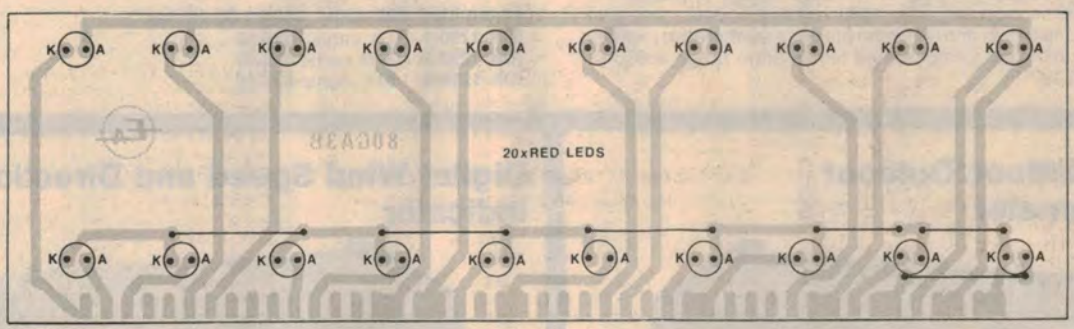
The microphone preamplifier consists of two high gain amplifiers in series, IC6c and IC7d. These provide the high gain necessary for an electret or low impedance microphone. Input impedance is 10k. This may be increased to 47k by increasing the input resistor to this value. This will also reduce the preamplifier gain by five

Figs 1 and 2 illustrate the operation of the Analyser and Peak Level Meter functions, respectively. Opposite page: the full circuit diagram. Only one filter is shown. The component values for the ten filters are tabulated on page 55.


GRAPHIC ANALYSER/PEAK LEVEL METER
SWITCH POSITIONS :
SELECTOR S1 : 1 : ANALYSER
2 : POWER
3 : VOLTAGE
APERTURE (POWER) S2 : 1 : 3dB (x1)
2 : 6dB (x10)
3 : 9db (x100)
*TANTALUM
D1-D20 : RED LEDS
IC1-IC10 : µA4136
MICROPHONE INPUT
LINE
MIC
100k LOG. ANALYSER
100k LOG PEAK LEVEL
RIGHT
LEFT
RIGHT SPEAKER
LEFT SPEAKER
POWER RANGE
APERTURE CONTROL
TO IC10c
TO IC10d
TO OTHER 9 FILTER INPUTS
TO OTHER 9 FILTER OUTPUTS
OTHER 9 FILTERS : IC6b,IC7a,b,IC8a,b, IC9a,b,IC10a,b.
S1b ROTOR
S1a ROTOR
MM5837
PINK NOISE
A&R2155
2x1N4002
240V
12.6V
CHASSIS
GREEN LED
LM340T-12
LM320T-12
GND LM340
GND LM320
+12V
-12V



Follow these diagrams carefully when assembling the two PC boards. The two boards are connected together by soldering the edge-connector patterns at right angles.



	1	2	3	4	5	6	7	8	9	10
R	10k	5.6k	5.6k	6.8k	6.8k	6.8k	8.2k	3.9k	3.9k	2.2k
C	0.47uF	.047uF	.022uF	.01uF	.0047uF	.0022uF	.001uF	.001uF	470pF	470pF
R1	3.9k	2.7k	2.7k	3.3k	1.8k	1.8k	2.7k	3.3k	3.3k	5.6k
R2	2.2M	1M	680k	560k	220k	180k	180k	150k	100k	120k
R3	39k	27k	27k	33k	18k	22k	33k	47k	47k	100k
C1	100uF	100uF	47uF	47uF	47uF	47uF	22uF	22uF	10uF	10uF

This table gives the component values of the 10 octave-band filters.

times, which is desirable for a high impedance microphone.

A transformer with 12.6V secondary powers the unit. It needs two half-wave rectifiers which develop about plus and minus 18 volts, which is further filtered and regulated down to ±12V DC by the three-terminal regulators.

CONSTRUCTION

The front panel and case dimensions match those of other units in the Playmaster series such as the Playmaster Twin 25 and the Playmaster Graphic Equaliser. As such, the new Playmaster is easy to build. All the circuitry is accommodated on two printed circuit boards which are attached to each other, at 90°. In spite of the relatively complex circuit functions, wiring has been kept to a minimum.

Assemble all the hardware into the chassis first. There is a good reason for this, so don't "roar off" into the PCB assembly just yet. Go ahead and mount all the hardware, including the decorative front panel. It is attached and held with the nuts of the potentiometer and switches.

The rear panel for our prototype was made from adhesive Scotchcal. We assume that kitset suppliers will supply this as well as the front panel.

The 6.5mm microphone socket mounted on the rear chassis must be insulated from chassis. This can be acheived using two insulating fibre washers (or you can make your own from the thick transparent plastic used for packaging shirts). Wrap insulating tape around the bush of the socket to ensure insulation from chassis. Alternatively, a rubber grommet of suitable

size can be used to isolate the socket from chassis.

With all the hardware mounted in the chassis you can install the mains wiring and some of the other wiring which does not involve the PCB. With that complete, you can turn attention to the PCBs. The display PCB is relatively straightforward as it accomodates only the twenty LEDs. It measures 203 x 59mm and is coded 80ga3b.

Each LED should be mounted so that it is spaced about 8mm from the PCB surface. Solder only one lead of each LED so that it can be adjusted later.

The main PCB measures 203 x 143mm and is coded 80ga3a. Mount all the links and small components first. We recommend that PC pins be installed for external connection. Take particular care to install the diodes and electrolytic capacitors with correct polarity. A they have no internal connections.

The three terminal regulator ICs require heatsinks. We made those for the prototype from 16-gauge aluminium, each measuring approximately 20 x 30mm.

With both PCBs complete, they can be soldered together. Position the display PCB exactly at 90° to the main PCB so that the top of the edge-connector pattern on the display PCB is just visible above the component side of the main PCB. Now tack the two edge connector patterns together in several places and then temporarily mount the assembly in the chassis to check that the LEDs will pass through the front panel holes. If not, adjust the two PCBs and solder all the connectors together. Now all the wiring can be connected to the PCB assembly. Use rainbow cable as much as possible, to give a neat appearance.

Parts List

1 PC board, 203 x 143mm, 80ga3a
1 PC board, 203 x 59mm, 80ga3b
1 plated steel chassis, 370 x 80 x 245mm with wrapover steel cover
1 front panel
1 adhesive label for rear panel
1 transformer, A&R 2155, DSE 2155
1 6-way RCA socket panel
1 4-way spring-loaded speaker terminal panel
1 100k rotary (log) potentiometer
1 100k dual ganged rotary (log) potentiometer
2 4-pole 3-position rotary switches
2 SPDT miniature toggle switches
1 6.5mm jack socket
4 adhesive rubber feet
4 brass spacers, 10mm long
1 3-pin mains plug and cord
1 3-way mains terminal strip
1 rubber grommet and cord clamp
32 PC stakes
Plus: hookup wire, solder lug, screws, nuts, washers, tinned copper wire, shielded audio cable.

SEMICONDUCTORS
2 1N4002 power diodes
12 1N4148 silicon signal diodes
20 large red LEDs
1 small green LED
1 LM340T-12 regulator
1 LM320T-12 regulator
1 MM5837 IC
10 uA4136 quad op amps

CAPACITORS
Electrolytics (PC mounting): 2 x 1000uF/25VW, 2 x 100uF/16VW, 4 x 47uF/16VW, 2 x 22uF/16VW, 2 x 10uF/16VW, 3 x 4.7uF/25VW.
Tantalum: 4 x 10uF/25VW
Metallised polyester (greencap): 1 x 1uF, 3 x 0.27uF, 3 x 0.18uF, 7 x 0.1uF, 4 x 0.47uF, 1 x 0.27uF, 2 x .022uF, 2 x .01uF, 2 x .0047uF, 2 x .0022uF, 4 x .001uF.
Polystyrene or Ceramic: 4 x 470pF, 3 x 39pF.

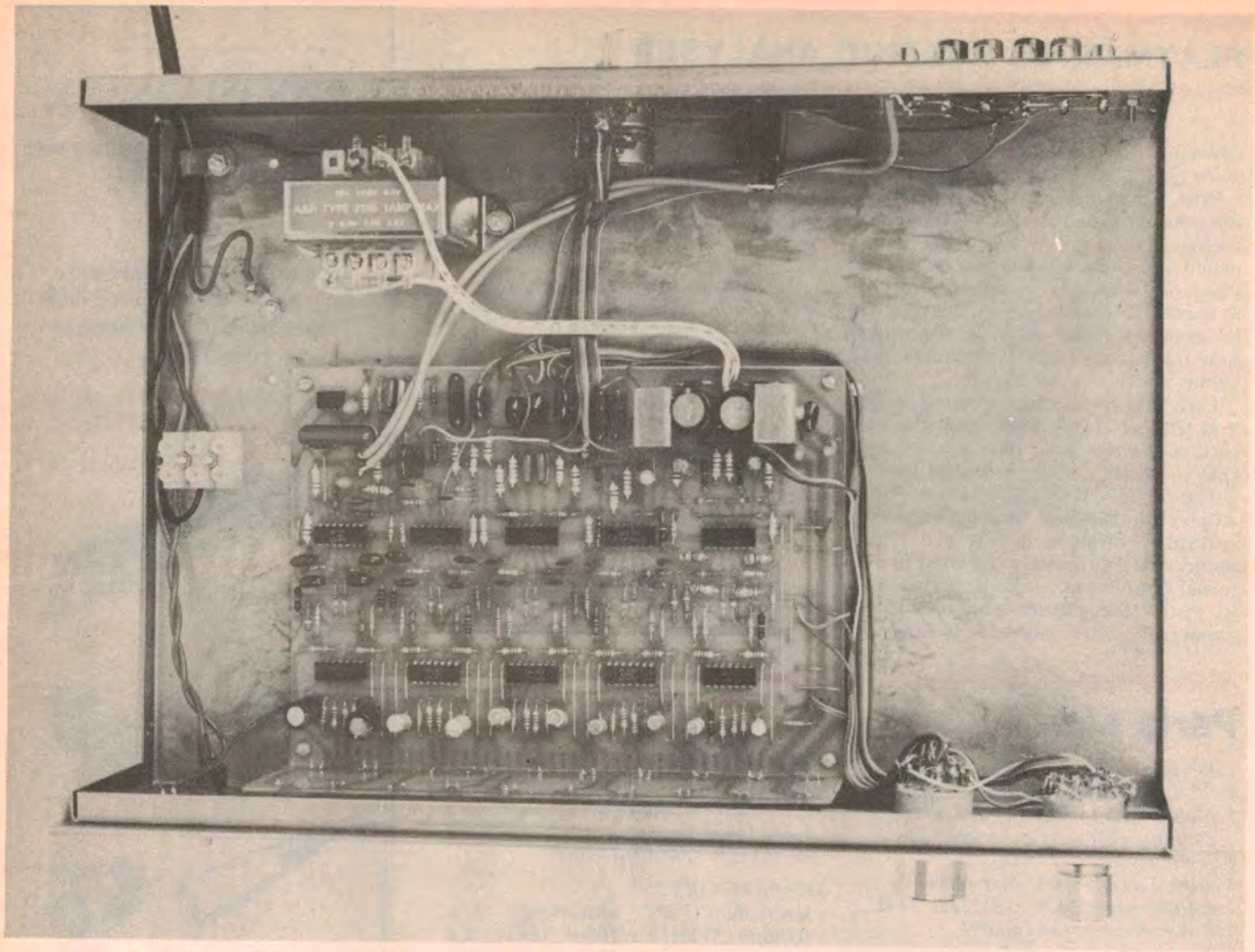
RESISTORS
3 x 2.2M, 2 x 1M, 1 x 820k, 4 x 680k, 3 x 560k, 2 x 390k, 4 x 220k, 2 x 180k, 5 x 150k, 2 x 120k, 6 x 100k, 1 x 82k, 4 x 68k, 2 x 56k, 2 x 47k, 3 x 39k, 3 x 33k, 2 x 27k, 3 x 22k, 1 x 18k, 2 x 15k, 1 x 12k, 18 x 10k, 2 x 8.2k, 4 x 6.8k, 3 x 5.6k, 2 x 3.9k, 5 x 3.3k, 5 x 3.3k, 3 x 2.7k, 1 x 2.2k, 2 x 1.8k, 20 x 1.5k, 1 x 1k, 1 x 470 ohm, 1 x 330 ohm, 1 x 100 ohm, 2 x 15 ohm.

similar comment applies to the orientation of the IC packages. Leave the MM5837 IC till last as it is a MOS device and requires precaution to prevent damage from static charges.

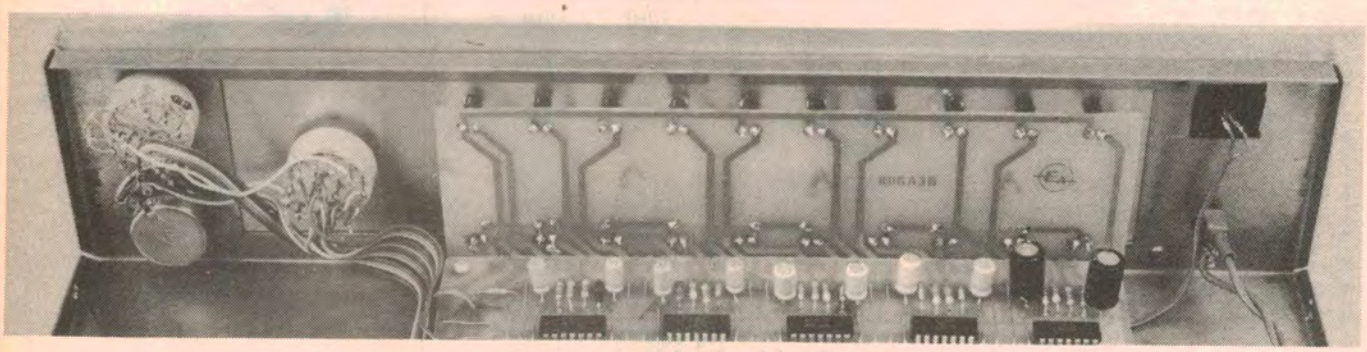
When you are ready to solder in the MM5837, connect the barrel of the soldering iron to the 0V line of the PCB, using a clip lead. Now solder pins 1, 2, 3 and 4 of the MM5837. The other pins may now be soldered although

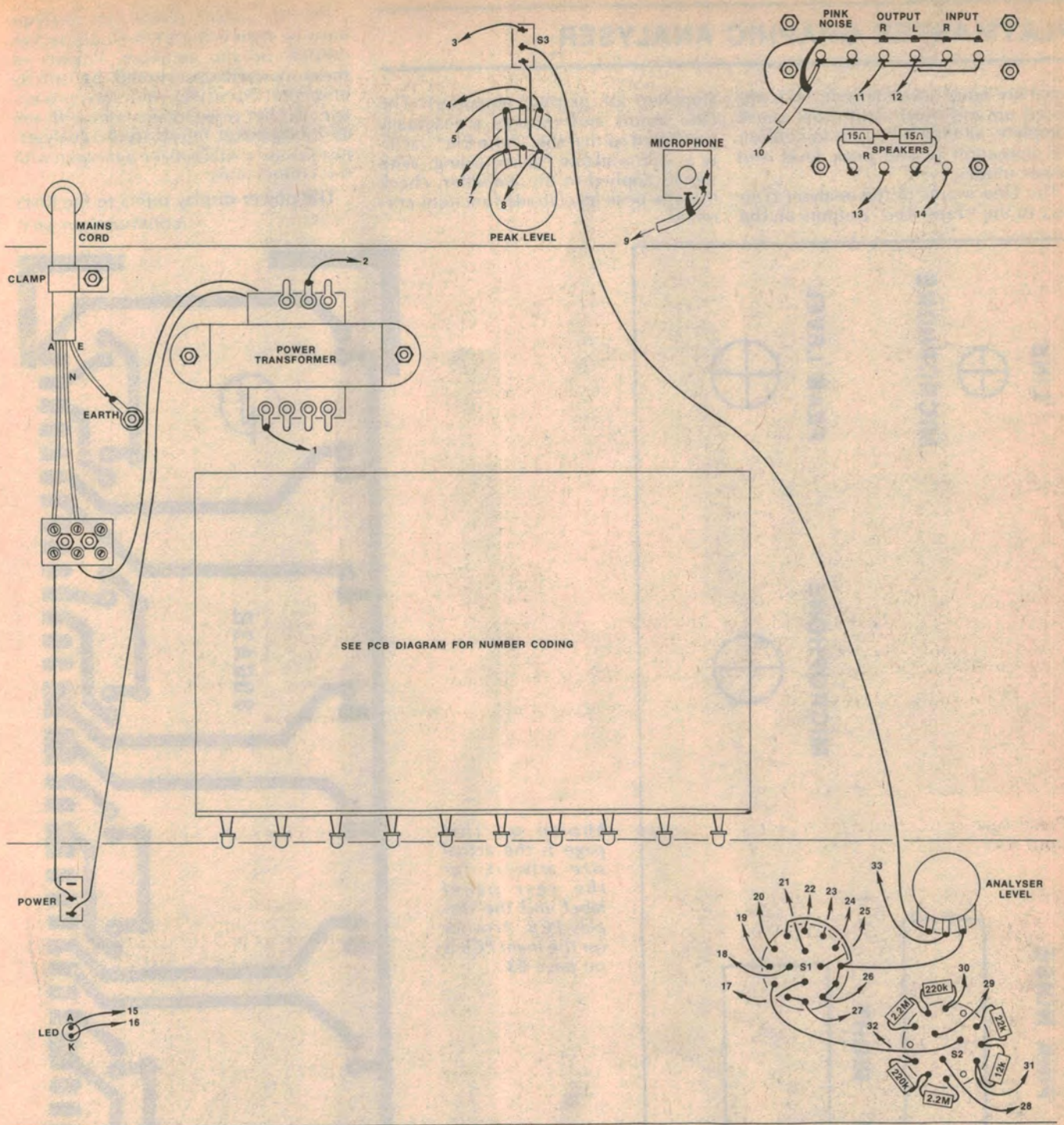
When all wiring is complete, make a thorough check of all your work and then apply power. Measure the voltages marked and then you should be ready to switch on and check the analyser functions. Connect the unit to your amplifier. Feed the pink noise into the amplifier and check that it works.

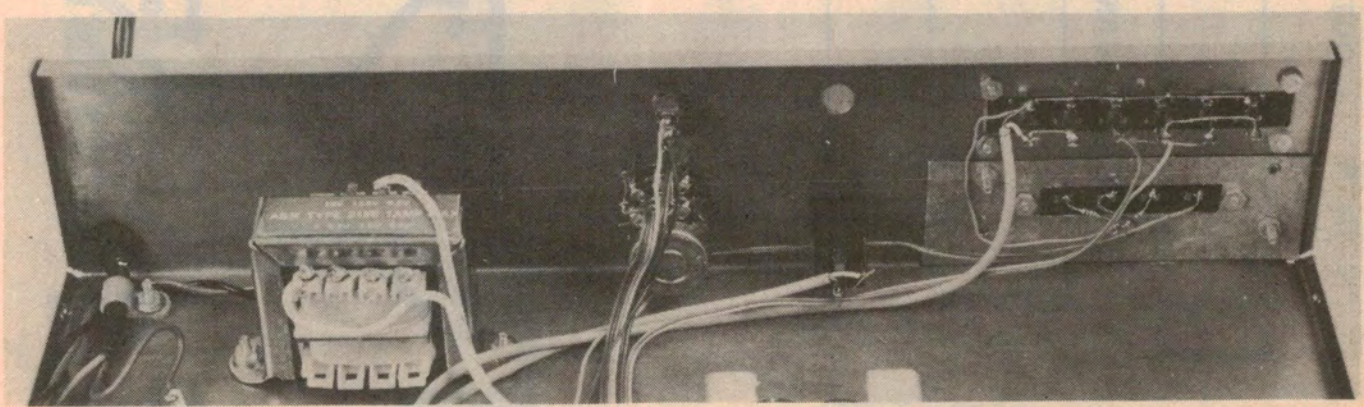
Now connect a good quality microphone and check that the LEDs in each octave band respond as the ap-



These views of our prototype show the simplicity of construction. At bottom of the page is the rear view showing the input sockets and peak level control.




PINK NOISE
OUTPUT R L
INPUT R L
11
12
10
15Ω
15Ω
SPEAKERS
R
L
13
14
3
S3
4
5
6
7
8
PEAK LEVEL
MICROPHONE
9
MAINS CORD
CLAMP
2
POWER TRANSFORMER
A
E
N
EARTH
1
SEE PCB DIAGRAM FOR NUMBER CODING
POWER
33
ANALYSER LEVEL
21
22
23
20
24
25
19
18
S1
26
30
17
220k
29
2.2M
27
22k
32
S2
12k
31
220k
2.2M
28
LED
A
K
15
16



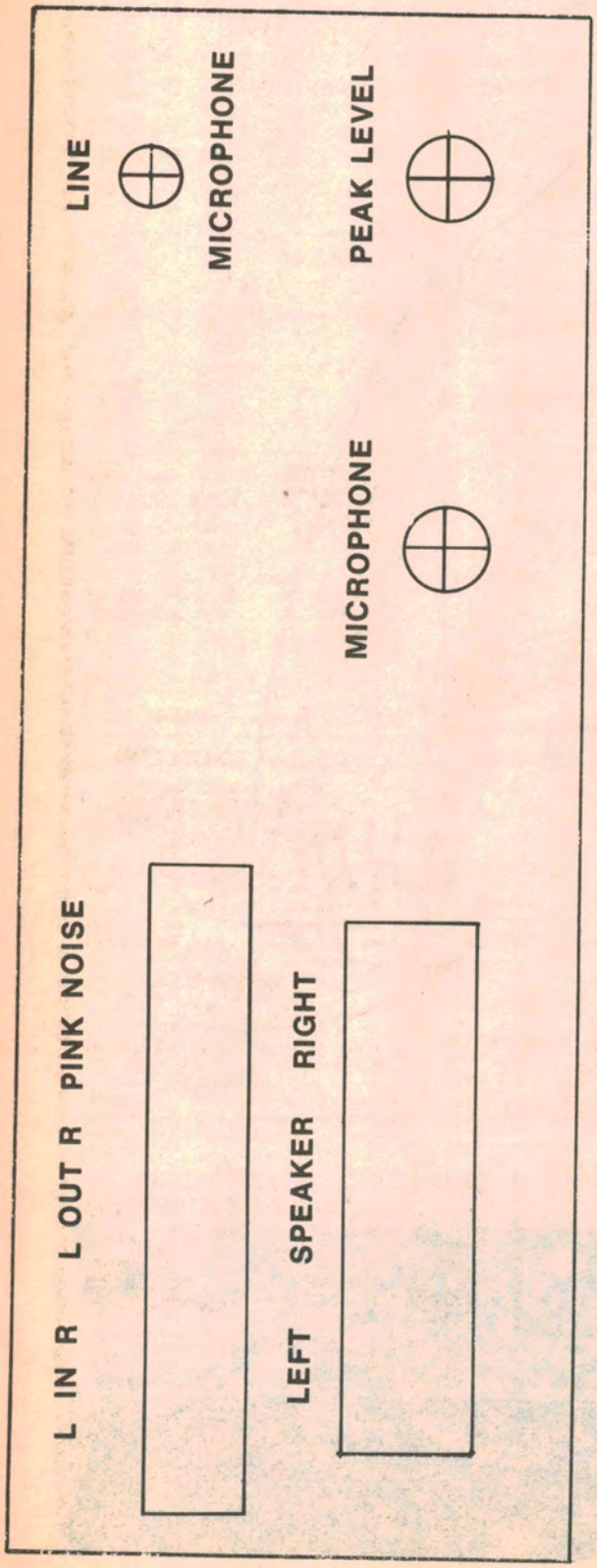
propriate equaliser slider control is adjusted up and down. With that check complete, all that remains is to confirm the operation of the peak level and power modes.

The Line inputs of the analyser connect to the "Tape Rec" outputs on the amplifier (or graphic equaliser). The Line inputs and outputs are actually paralleled so that the "Tape Rec" facility is still available for recording. With signals applied to the amplifier, check that the peak level mode functions correctly.

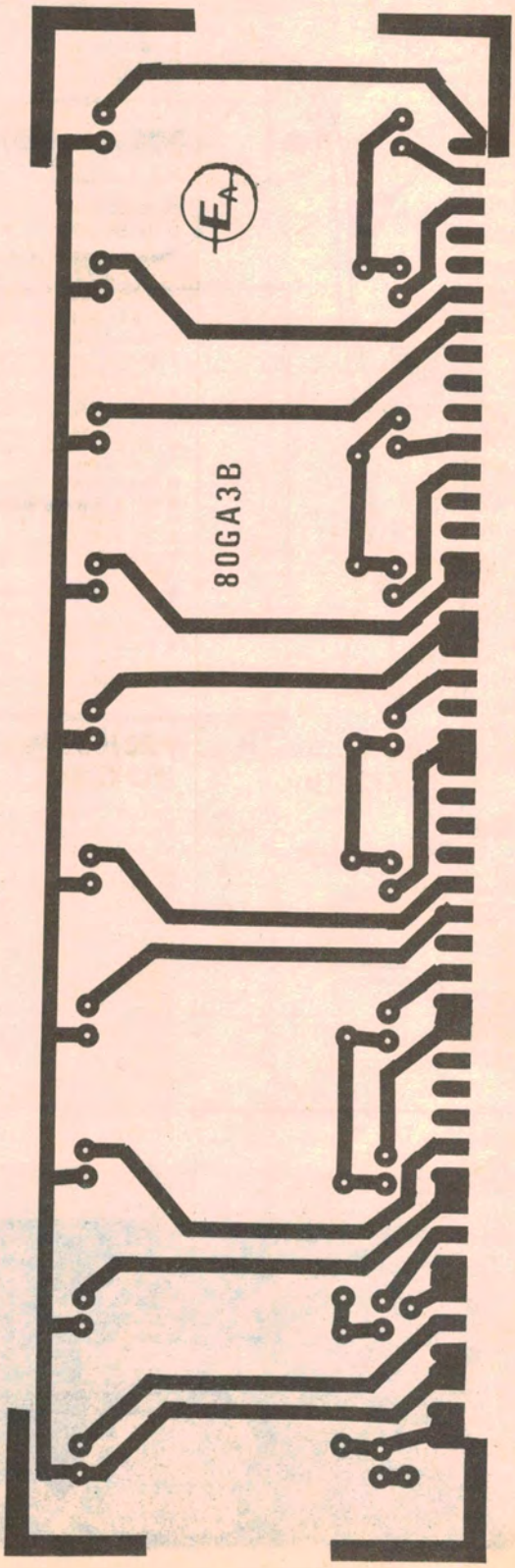
For the power mode, the analyser must be connected to the loudspeaker outputs on the amplifier. Polarity of these connections should be strictly observed. Note that there are protective 15 ohm resistors in series with the 0V loudspeaker inputs to the analyser, just in case you do make a mistake with the connections.

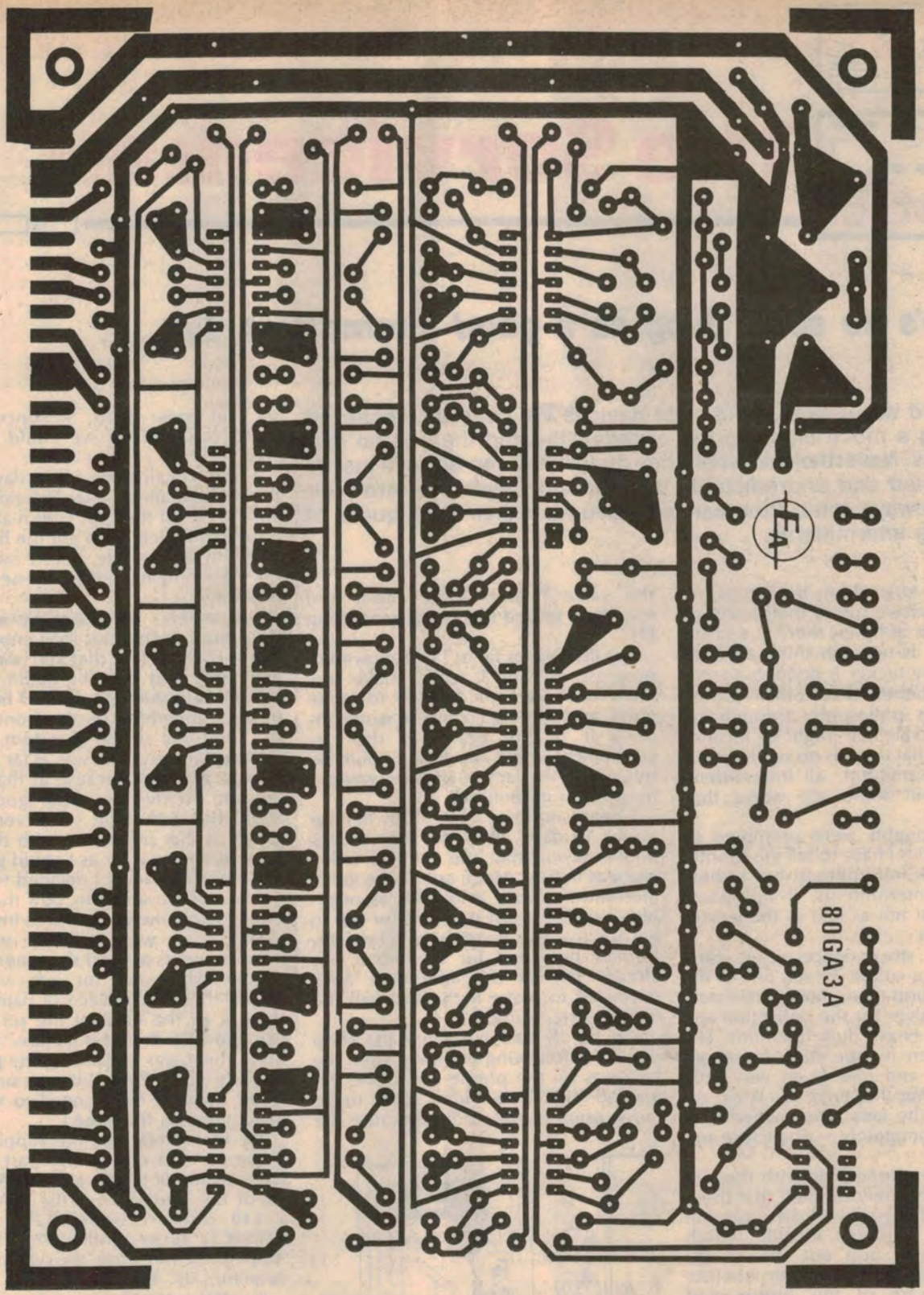
The power display refers to the RMS

(continued on p63)



Shown on this page is the actual size artwork for the rear panel label and the display PCB. Artwork for the main PCB is on page 63.





sinewave power into a resistive 8 ohm load. You can refer the power into 4 ohm loads or 16 ohm loads by changing the circuit slightly. For 4 ohm loads, the 10k resistor in the input voltage divider (associated withe S1b and S1a) should be changed to 4.7k. For 16 ohm loads, change it to 22k.

If both the analyser level and line level controls are wound up to maximum, and there are no connections to the line inputs supersonic oscillation may result and some of the LEDs will turn on. This is not a fault and is a natural consequence of the high input impedance and large gains used. The condition will disappear immediately when normal connections are made to the line inputs, whether or not there is an input signal.

We estimate that the current cost of parts for this project is approximately

$95

This includes sales tax but does not include a microphone or connecting cables.