

Versatile 4-Input Mixer

... with tone controls and a built-in amplifier

This low-cost 4-input mixer features low-noise input preamps, each of which can be configured to suit a wide range of signal sources: microphones, guitar pick-ups, tape decks, synthesisers or CD players. Other features include a built-in equaliser with bass, midrange and treble controls, along with a monitoring amplifier which can drive stereo headphones.

By JIM ROWE



Input Mixer

uilt-in headphone amp!



Specifications

Input sensitivity (for 2.0V RMS output, each main preamp configuration):

Dynamic mic, low impedance	2.6mV RMS
Electric guitar	28mV RMS
Tape deck	145mV RMS
CD player	463mV RMS

Frequency response -3dB at 23Hz and 40kHz, -1dB at 40Hz and 22kHz
(with tone controls flat; see Fig.4)

Maximum output 3.2V RMS (9V p-p) before clipping; see Fig.6

Output noise level (with respect to 2V RMS output, maximum gain and volume, tone controls flat, inputs terminated with 1k Ω , unweighted 22Hz-22kHz bandwidth)

CD player input	-92dB unweighted; -96dB A-weighted
Tape deck input	-92dB unweighted; -96dB A-weighted
Guitar input	-85dB unweighted; -89dB A-weighted
Low-Z mic input	-67dB unweighted; -70dB A-weighted

Total harmonic distortion (THD) Less than 0.01% up to 3.2V RMS output

Graphic equaliser

Bass	+13dB and -12.5dB at 100Hz, \pm 18dB at 40Hz, \pm 0.5dB at 1kHz
Mid-range	\pm 11dB at 1kHz, \pm 1dB at 100Hz, \pm 2.5dB at 10kHz
Treble	\pm 10.5dB at 12kHz, \pm 1dB at 1kHz, \pm 11.5dB at 15kHz

Headphone amplifier

Output voltage before clipping	590mV RMS into 2 x 33 Ω loads
THD for 500mV RMS into 2 x 33 Ω loads	0.8%

Supply voltage 12V DC (nominal) - see text

Maximum current drain 45mA

Constructional Project

IT IS MANY, many years since we published a design for a low-cost four-input guitar mixer module for small bands and groups. Although it was very popular, it apparently wasn't quite as flexible as many users wanted, particularly in terms of its ability to configure the input preamps for signal sources other than guitar pick-ups – eg, for dynamic mics, tape decks, CD players and synthesisers. It also didn't include a built-in headphone amplifier for monitoring.

These shortcomings have been addressed in this design. There's now more flexibility in configuring the input preamps, together with a built-in headphone amplifier.

Block diagram

The block diagram for the Versatile 4-Input Mixer is shown in Fig.1. It provides four inputs, each with its own preamp stage and gain control. Each of the four input preamps can be configured by the user to provide the appropriate gain and input impedance values to suit a wide range of signal sources – from the millivolt or two of a low-impedance dynamic mic to the 1V to 2V signals of a CD/MP3 player or keyboard synthesiser. This makes the unit very versatile.

Following the input gain controls, there's a standard mixer stage, to allow the signals to be combined in whatever proportions you wish. The resulting composite audio signal is then fed to a 3-channel 'mini equaliser' stage, where three tone controls (bass, mid-range and treble) allow you to adjust the tonal balance.

This equaliser stage is basically an expanded version of a standard 'Baxandall' feedback tone control, with three controls instead of two.

From there, the output of the equaliser stage is passed to the master volume control and finally to the output jack, via an output buffer amplifier operating with a gain of 2.2.

The headphone amplifier (shown above the output buffer) allows the output audio signal to be monitored via a pair of standard stereo headphones.

The mixer circuit operates from a single 12V DC supply. This can be provided either by a mains plugpack or a 12V battery, making the unit suitable for portable and mobile use. The current drain is less than 50mA.

All components are mounted on a single PC board for ease of assembly and although the board is a little on the

large size, we've made it just the right size to fit snugly into a 225 × 165 × 40mm low-profile plastic instrument case.

Circuit details

The full circuit diagram for the Versatile 4-Input Mixer is shown in Fig.3. It's quite easy to relate each circuit section to its corresponding block in Fig.1.

At the far lefthand side are the four signal input jacks CON1 to CON4, each connected to its own preamp stage and gain control. These preamps each use one section of an LM833 low-noise dual op amp IC – ie, two ICs are used (IC1 and IC2).

Although the four preamps shown in Fig.3 all have exactly the same circuit configuration, some of the components in each stage do not have specific values. Instead they have symbolic values like R_m , R_{in} , R_{za} , R_{zb} , R_f and C_f , to indicate their basic function rather than their value. This is because their values need to be chosen when each preamp is configured to suit a particular signal source.

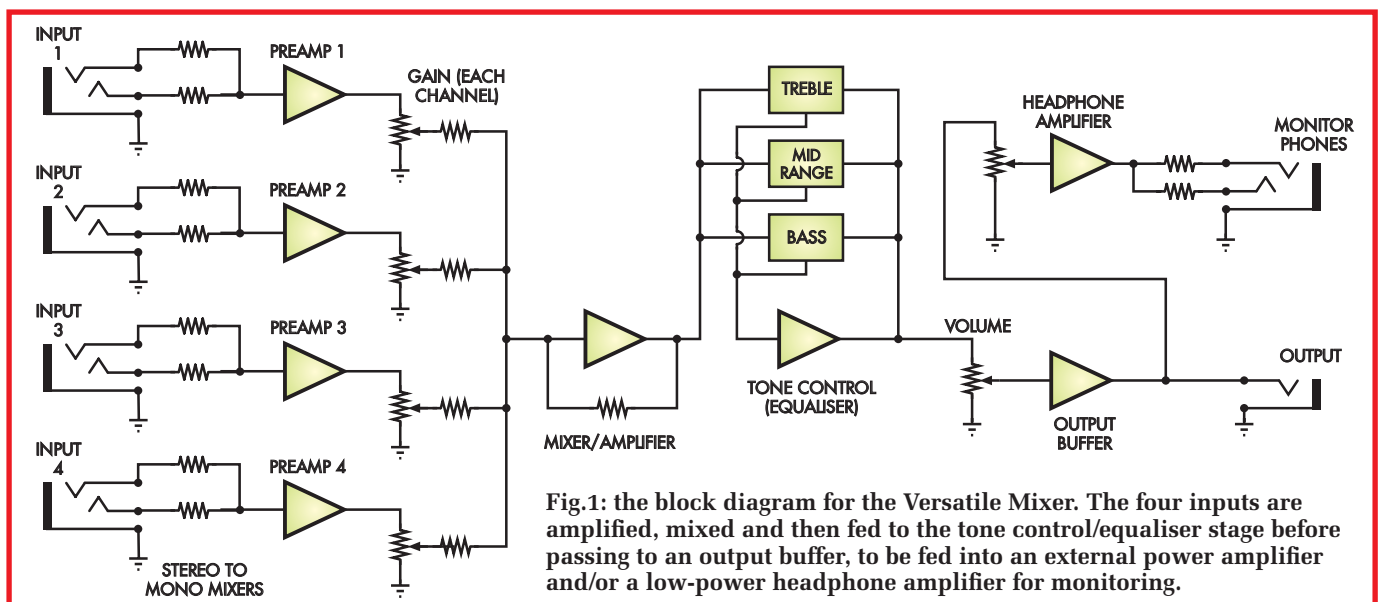
Specifically, R_m , R_{in} , R_{za} and R_{zb} are given values to provide the appropriate input impedance for the source, while R_f and C_f are given values to provide the appropriate gain and/or signal handling capability. The inset table in the circuit diagram gives the values for each of the various input sources.

As the mixer is a mono device and there is a good chance that stereo devices may be connected to it (eg, an MP3 or CD player) all four channels have the capability of being 'summed' to mono via R_{ma} and R_{mb} – again, the values are shown in the inset table.

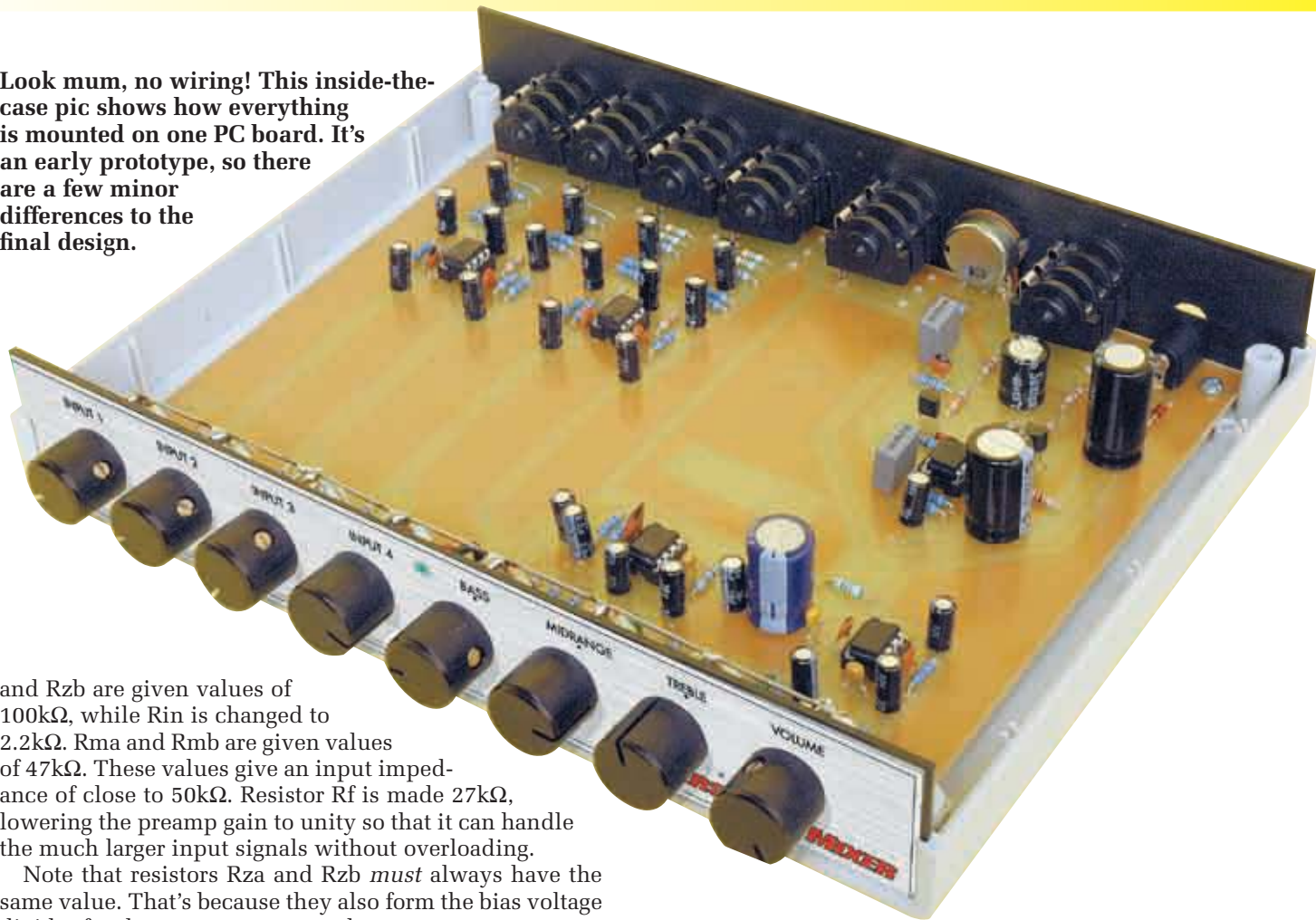
Some devices, such as microphones, are generally mono, so R_{ma} and R_{mb} may be substituted with links and/or omitted completely. Yes, we know there are stereo microphones out there, but these are the exception, not the rule.

For example, to configure a preamp for an electric guitar input, R_{in} , R_{za} and R_{zb} are $1M\Omega$ (giving an input impedance of $330k\Omega$), while R_f is $22k\Omega$ (to give a gain of 19 times, or about 25dB). Finally, C_f is given a value of $100pF$ to ensure stability.

Similarly, to configure a preamp for the much higher stereo output from a CD player or synthesiser keyboard, R_{za}



Look mum, no wiring! This inside-the-case pic shows how everything is mounted on one PC board. It's an early prototype, so there are a few minor differences to the final design.



and R_{zb} are given values of $100\text{k}\Omega$, while R_{in} is changed to $2.2\text{k}\Omega$. R_{ma} and R_{mb} are given values of $47\text{k}\Omega$. These values give an input impedance of close to $50\text{k}\Omega$. Resistor R_f is made $27\text{k}\Omega$, lowering the preamp gain to unity so that it can handle the much larger input signals without overloading.

Note that resistors R_{za} and R_{zb} *must* always have the same value. That's because they also form the bias voltage divider for the preamp concerned.

No provision has been made for powering electret microphones, but in a permanent installation this could be easily achieved through the use of a suitable bias resistor ($10\text{k}\Omega$ is commonly used) from the nominal 12V line to the 'hot' input of the electret.

Preamp outputs

The outputs from the preamp stages are fed via $2.2\mu\text{F}$ electrolytic capacitors to gain control potentiometers VR1 to VR4. The signals at the wipers (moving contacts) are then fed, via $47\text{k}\Omega$ mixing resistors and a $2.2\mu\text{F}$ capacitor, to pin 2 input of mixer/amplifier stage IC3a.

IC3a operates as a standard inverting amplifier with a gain of -2 ($100\text{k}\Omega/47\text{k}\Omega$) for each of the four inputs. It also provides a low 'virtual earth' input impedance, to ensure that there is no interaction between the four gain controls (VR1 to VR4).

A half-supply rail bias (+6V) for IC3a is provided by op amp IC3b. This is connected as a voltage follower with its pin 5 input set at +6V by a voltage divider consisting of two $47\text{k}\Omega$ resistors across the supply rail. The resulting +6V bias voltage from pin 7 of IC3b is applied to pin 3 of IC3a via a $100\text{k}\Omega$ resistor. It's also used to bias op amps IC4a (pin 3) and IC4b (pin 5).

Tone control stage

The heart of the tone control/equaliser stage is IC4a. As mentioned previously, this is an extended version of the standard Baxandall feedback tone control configuration – ie, it has three controls instead of the usual two. The operation is exactly the

same though, with each pot (VR5, VR6 and VR7) acting as a gain control for signals within a set frequency range.

In operation, the pots vary the effective negative feedback ratios for their respective frequency bands.

Fig.2 shows a simplified scheme for the bass control. When the pot is in its centre position, IC4a has equal input and feedback impedances for the frequencies in its control range, thus giving it unity gain for those frequencies.

However, when the pot is turned to the 'maximum boost' (fully clockwise) position, the ratio of the feedback and input impedances increases to 11:1 ($110\text{k}\Omega/10\text{k}\Omega$), so the stage gain for those frequencies increases to 11 times or +21dB.

Conversely, when the pot is turned to the 'maximum cut' (fully anticlockwise) position, the ratio of feedback and input impedances reduces to 1:11 ($10\text{k}\Omega/110\text{k}\Omega$). As a result, the stage no longer amplifies those frequencies but

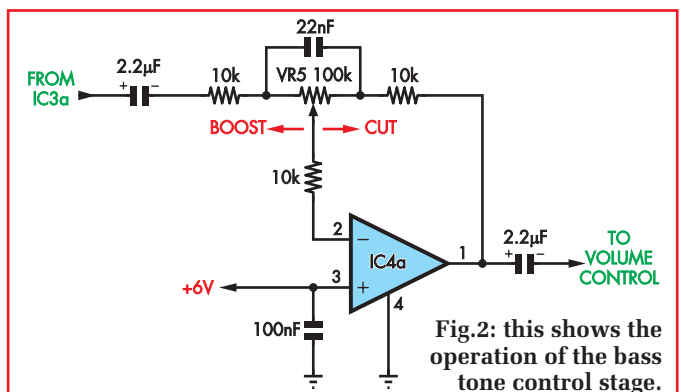
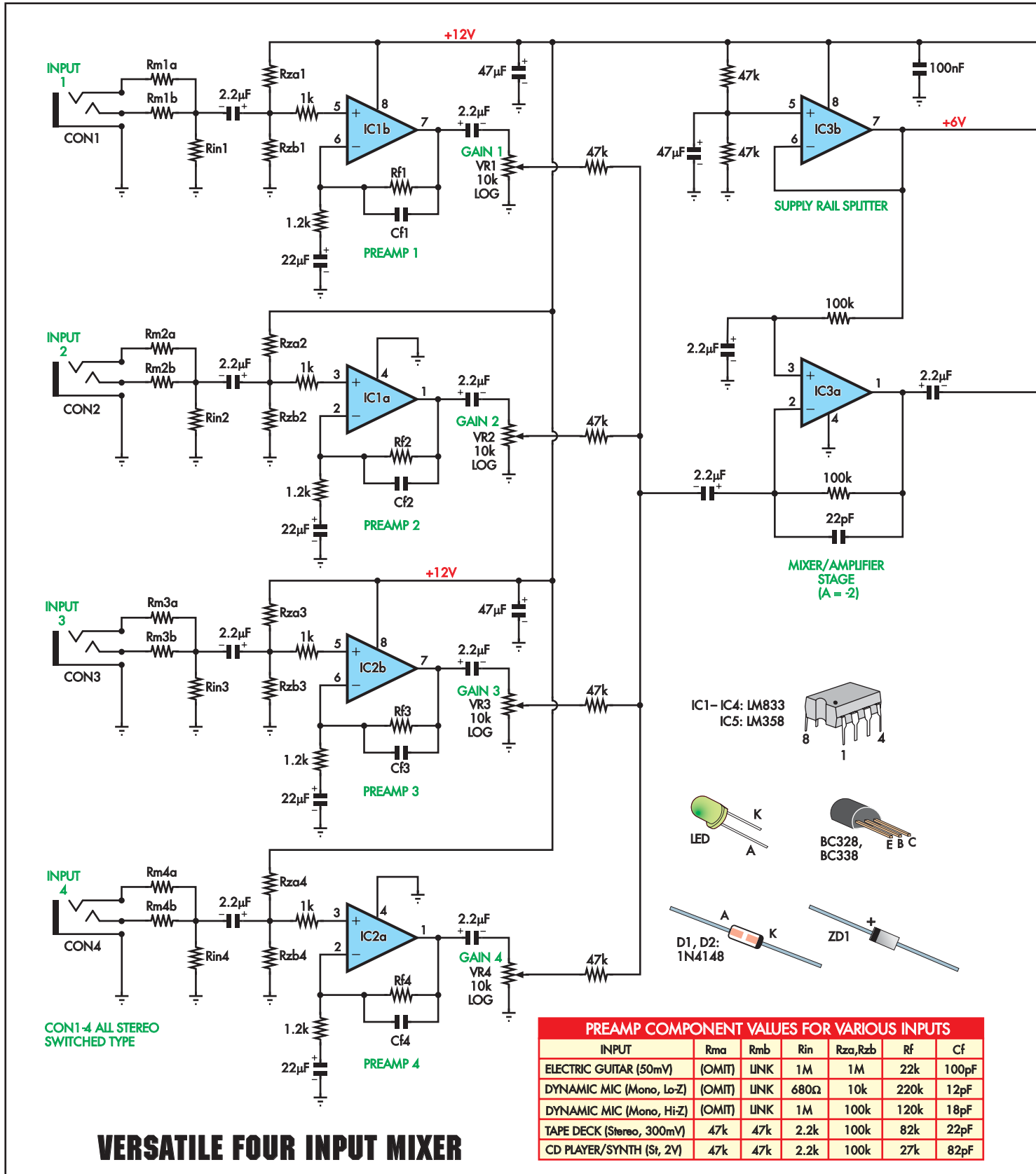


Fig.2: this shows the operation of the bass tone control stage.

Constructional Project



attenuates them instead – ie, by about 11 times, or –21dB.

Going back to Fig.3, all three tone controls act in this same way, but each covers its own range of frequencies, as determined by the values of the various capacitors in the feedback networks.

IC4a's output appears at pin 1 and is AC-coupled to VR8, which is the master volume control. This controls the signal level fed to output buffer stage IC4b, which is configured as a standard inverting amplifier with a gain of 2.2 (22kΩ/10kΩ). Its output is in turn fed to output jack CON5 via a 2.2µF DC blocking capacitor.

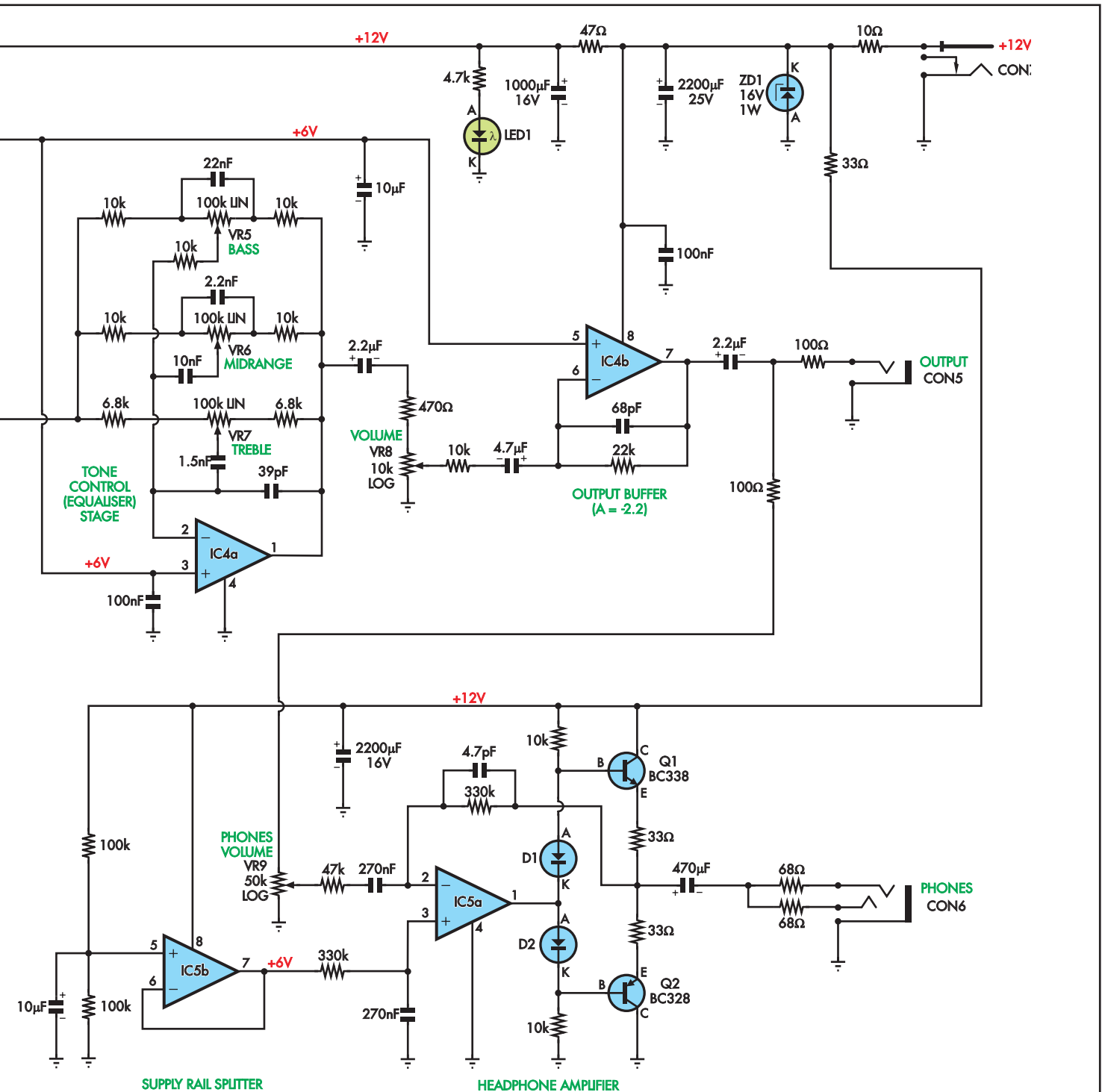


Fig.3: don't be daunted by the size of the circuit diagram – it really is quite an easy project to understand (especially when you compare it to the block diagram). And the good news is it's even easier to put together because all components mount on a single PC board. No wiring should mean no mistakes.

Headphone amplifier

The output signal at CON5 is also used to feed the headphone amplifier (IC5a), via a 100Ω isolating resistor and potentiometer VR9 (the headphone volume control). The headphone amplifier itself is based on IC5a, which is half of an LM358 low-power dual op amp. IC5b is wired in a

similar manner to IC3b (ie, as a voltage follower) and is used to bias pin 3 of IC5a to +6V.

Transistors Q1 and Q2 are used to boost the output current capability of IC5a, to provide sufficient drive for both sides of a standard low-impedance stereo headphones/ear buds (33Ω per earpiece). These transistors are configured

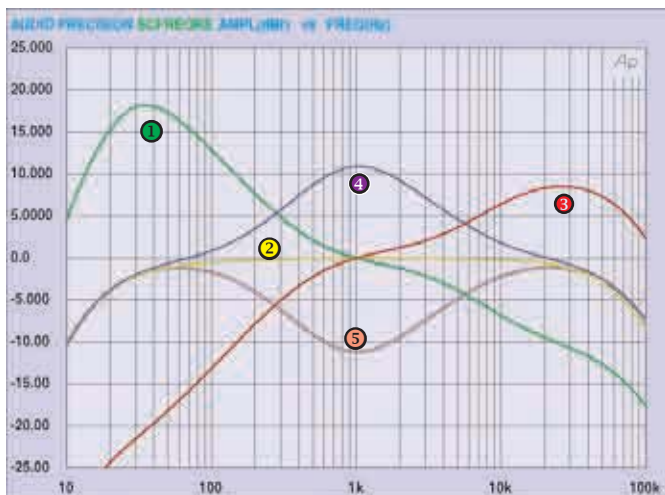


Fig.4: this complex frequency plot is the result of five frequency sweeps with different tone control settings. The green trace ① is taken with maximum bass boost, mid-range flat (centred) and maximum treble cut. The yellow trace ② is taken with all tone controls flat (centred). The red trace ③ is taken with maximum bass cut, mid-range flat (centred) and maximum treble boost. The purple trace ④ is taken with bass and treble controls flat and maximum mid-range boost while the pink trace ⑤ is taken with bass and treble controls flat and maximum mid-range cut. Note that the tone controls do interact with each other.

as complementary emitter followers, with diodes D1 and D2 setting their quiescent bias levels.

Negative feedback for the stage is taken from the junction of the two 33 Ω emitter resistors and applied to pin 2 of IC5a via a 330k Ω resistor, ie, transistors Q1 and Q2 are inside the feedback loop. This reduces the distortion level of the headphone amplifier and also flattens its frequency response. The 4.7pF capacitor across the 330k Ω resistor rolls off the response above 100kHz to ensure stability.

Power supply

To make it as versatile as possible, power for the mixer is derived from either an external 12V DC regulated plugpack supply or from a 12V battery. This is applied via connector CON7 and powers all the mixer circuitry.

Reverse polarity protection is not provided by a series diode, but instead by a 10 Ω series resistor and Zener diode ZD1, which also protects the circuit from over-voltage damage. If you connect a plugpack with the wrong polarity (ie, centre negative instead of the more usual centre positive) the 10 Ω resistor should burn out, cutting power from the circuit.

A single 3mm 'power on' high-brightness LED connects across the 12V supply via a 4.7k Ω current-limiting resistor.

The 2200 μ F electrolytic capacitor across ZD1 decouples and filters the supply rail, while the rail to the headphone amplifier is further decoupled using a separate 33 Ω resistor and 2200 μ F capacitor. This is done to prevent unwanted interaction between the headphone amplifier and the rest of the circuit due to supply rail fluctuations.

Additional supply decoupling for the +12V rail to the LM833 op amps is provided by a 47 Ω resistor and 1000 μ F capacitor. This eliminates any possibility of low frequency 'motor-boating' when high gain is used on all the input channels, together with maximum bass boost.

It also makes it possible to use an unregulated 9V DC plugpack at a pinch – hum will be higher, but at least it might get you out of trouble if the specified regulated 12V DC plugpack is unavailable.

Self-contained battery power?

We know it's going to be asked, so we will answer the question: can you make the mixer portable and run it from internal batteries – say a couple of 9V alkalines?

The answer, with a couple of reservations, is yes, it is possible – because the op amps set up the half-supply rails.

The two batteries could occupy the vacant real estate in the middle of the PC board. (You'd obviously need to fix these in position on the PC board, but that shouldn't be difficult, given the amount of earth track in this area).

A couple of riders though: the mixer draws about 20mA *without* the headphone amplifier being used, so even new alkaline 9V batteries are only likely to give you a few hours operation at best. If you use the headphone amp, expect even less. But that period might be long enough for your application. And to use an 18V supply, you would need to change the 16V Zener to a 22V type. You would also probably want to fit a small power on/off switch.

Construction

Another of the major features of this design, one that we haven't mentioned earlier, is the fact there is no wiring to be done! Everything – including the input/output sockets and control pots – is mounted on the single PC board. This makes building this mixer very easy.

This PC board is coded 704, measures 198 \times 156mm and fits neatly inside a standard low-profile ABS instrument case measuring 225 \times 165 \times 40mm. The printed circuit board is available from the *EPE PCB Service* – see page 70.

As can be seen from the photos, all but one of the control pots are mounted along the front of the board, the exception being the headphone volume control pot (VR9). There simply wasn't enough room for it on the front, so it was mounted adjacent to headphone jack (CON6) on the rear panel.

Note that the board has been designed to suit standard low-cost switched 6.35mm jack sockets for CON1 to CON6, but the board will also accept the unswitched stereo type. The reason we use switched stereo sockets is so that unused inputs are shorted to 'earth', thus minimising noise.

Fig.7 shows the parts layout on the PC board. Begin construction by carefully inspecting the PC board for etching defects, then start the assembly by fitting the six wire links.

Follow these with the resistors. You will have to decide how you wish to configure each input and then choose resistors Rma, Rmb, Rin, Rza, Rzb and Rf from the table on the circuit diagram accordingly. We've shown the resistor colour codes (and capacitor codes) but you should also check the resistor values using a digital multimeter, as some colours can be difficult to decipher.

The non-polarised capacitors can go in next. Again, the feedback capacitors (Cf1 to Cf4) will have to be selected from the circuit diagram inset table. The polarised electrolytics can now be fitted, taking care to ensure they go in with the correct polarity.

Next, fit the sockets for the five ICs, making sure you orientate them with their 'notched' ends as indicated in Fig.7. Follow these with diodes D1 and D2, Zener diode

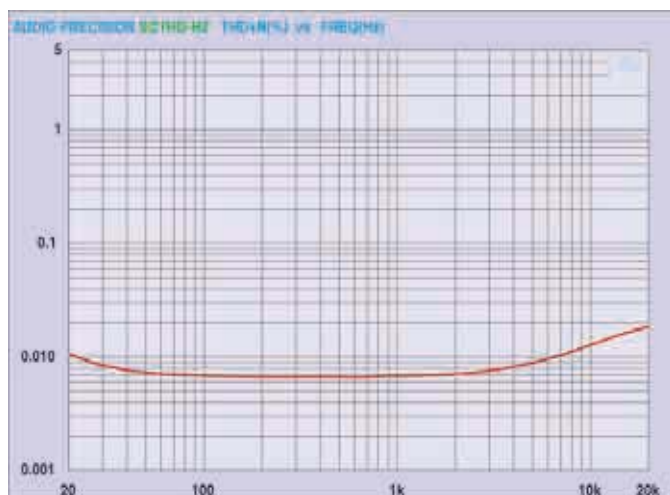


Fig.5: this graph shows total harmonic distortion versus frequency at an output of 2V RMS. The measurement bandwidth is 22Hz to 80kHz.

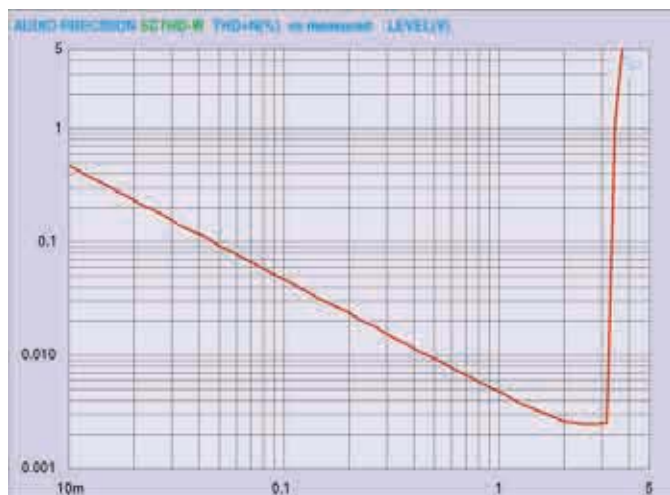


Fig.6 shows total harmonic distortion versus output level at a frequency of 1kHz. The measurement bandwidth is 22Hz to 22kHz. The rising value at lower signal levels is solely due to the residual noise at around -92dB with respect to 2V. Since the residual noise is fixed, it results in higher THD values as the signal level is reduced. In reality, the harmonic distortion is less than 0.003% at 1kHz, for all signal levels up to 2V RMS.

ZD1 and transistors Q1 and Q2, again making sure they have the correct orientation.

Potentiometers VR1 to VR9 can now be fitted. Before doing so, cut each pot's spindle to a length of 10mm using a small hacksaw and then use a small file to remove any burrs. This step will not be necessary if you use 'metric' pots with 10mm long splined shafts and matching splined knobs.

Note that the three 100k Ω linear units (usually marked B100K) must be fitted in the VR5, VR6 and VR7 positions along the front of the board. The five 10k Ω log pots (probably marked A10K) go in positions VR1 to VR4 and VR8, while the remaining 50k Ω log pot (marked A50K) is fitted as VR9 at the rear.

It's just a matter of pushing each pot as far down as it will go onto the board and soldering its pins. Once they're all in, scrape or file away some of the plating at the top of each of the VR1 to VR8 pot bodies and

Parts List – Versatile 4-Channel Mixer

- 1 PC board, code 704, size 198 × 156mm. This board is available from the *EPE PCB Service*.
- 6 6.35mm switched stereo jack sockets, PC board mounting (CON1-6)
- 1 2.5mm concentric DC socket, PC-mount (CON7)
- 9 16mm diameter aluminium knobs
- 5 8-pin DIL sockets (for IC1-IC5)
- 1 200mm length of 0.25mm tinned copper wire
- 1 Low profile ABS instrument case, size 225 × 165 × 40mm

Semiconductors

- 4 LM833 dual low-noise op amp (IC1-IC4)
- 1 LM358 dual op amp (IC5)
- 1 BC338 *NPN* transistor (Q1)
- 1 BC328 *PNP* transistor (Q2)
- 1 16V 1W Zener diode (ZD1)
- 1 3mm high-brightness LED (LED1)
- 2 1N4148 signal diodes (D1,D2)

Capacitors

- 2 2200 μF 25V radial electrolytic
- 1 1000 μF 25V radial electrolytic
- 1 470 μF 25V radial electrolytic
- 3 47 μF 16V radial electrolytic
- 4 22 μF 16V radial electrolytic
- 2 10 μF 16V radial electrolytic
- 1 4.7 μF 16V radial electrolytic
- 13 2.2 μF 16V radial electrolytic
- 2 270nF MKT metallised polyester
- 3 100nF multilayer monolithic
- 1 22nF metallised polyester
- 1 10nF metallised polyester
- 1 2.2nF metallised polyester
- 1 1.5nF metallised polyester
- 1 68pF disc ceramic, NPO
- 1 39pF disc ceramic, NPO
- 1 22pF disc ceramic, NPO
- 1 4.7pF disc ceramic, NPO
- 4 ceramic caps, selected values (Cf1-Cf4)

Resistors (1%, 0.25W)

- | | | | | |
|-----------------|-----------------|-----------------|----------------|----------------|
| 2 330k Ω | 4 100k Ω | 7 47k Ω | 1 22k Ω | 8 10k Ω |
| 2 6.8k Ω | 1 4.7k Ω | 4 1.2k Ω | 4 1k Ω | 1 470 Ω |
| 2 100 Ω | 2 68 Ω | 3 33 Ω | 1 47 Ω | 1 10 Ω |

Up to 8 47k Ω input mixer resistors, (Rma1-4 and Rmb1-4) [omit for mono sources and use some links instead]

4 input resistors, selected values (Rin1-Rin4)

8 bias divider resistors, selected values (Rza1-Rza4 and Rzb1-Rzb4)

4 feedback resistors, selected values (Rf1-Rf4)

Potentiometers

- 5 10k Ω log pots, PC-mount 16mm (VR1-VR4,VR8)
- 3 100k Ω linear pot, PC-mount 16mm (VR5-VR7)
- 1 50k Ω log pot, PC-mount 16mm (VR9)

Constructional Project

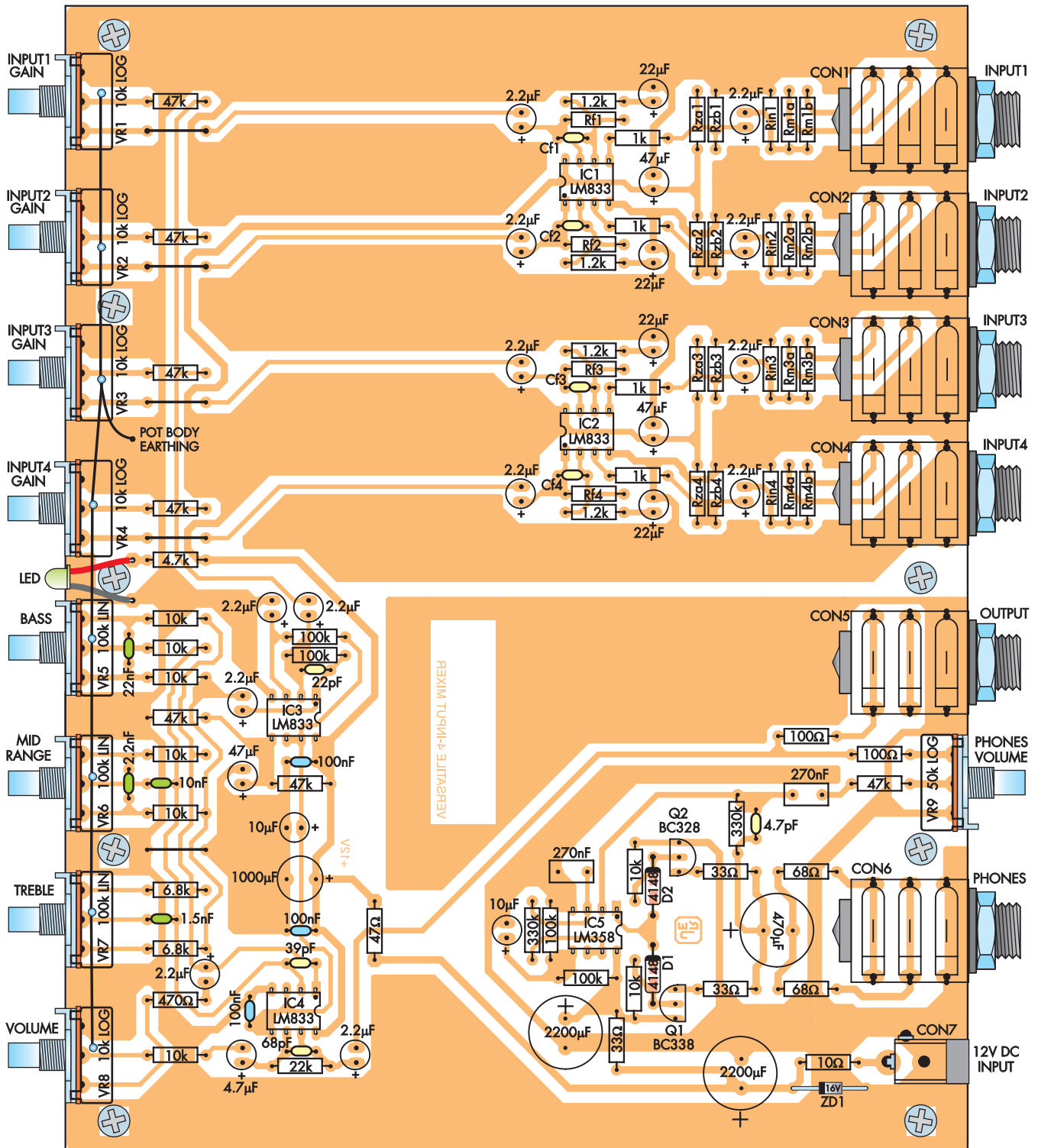


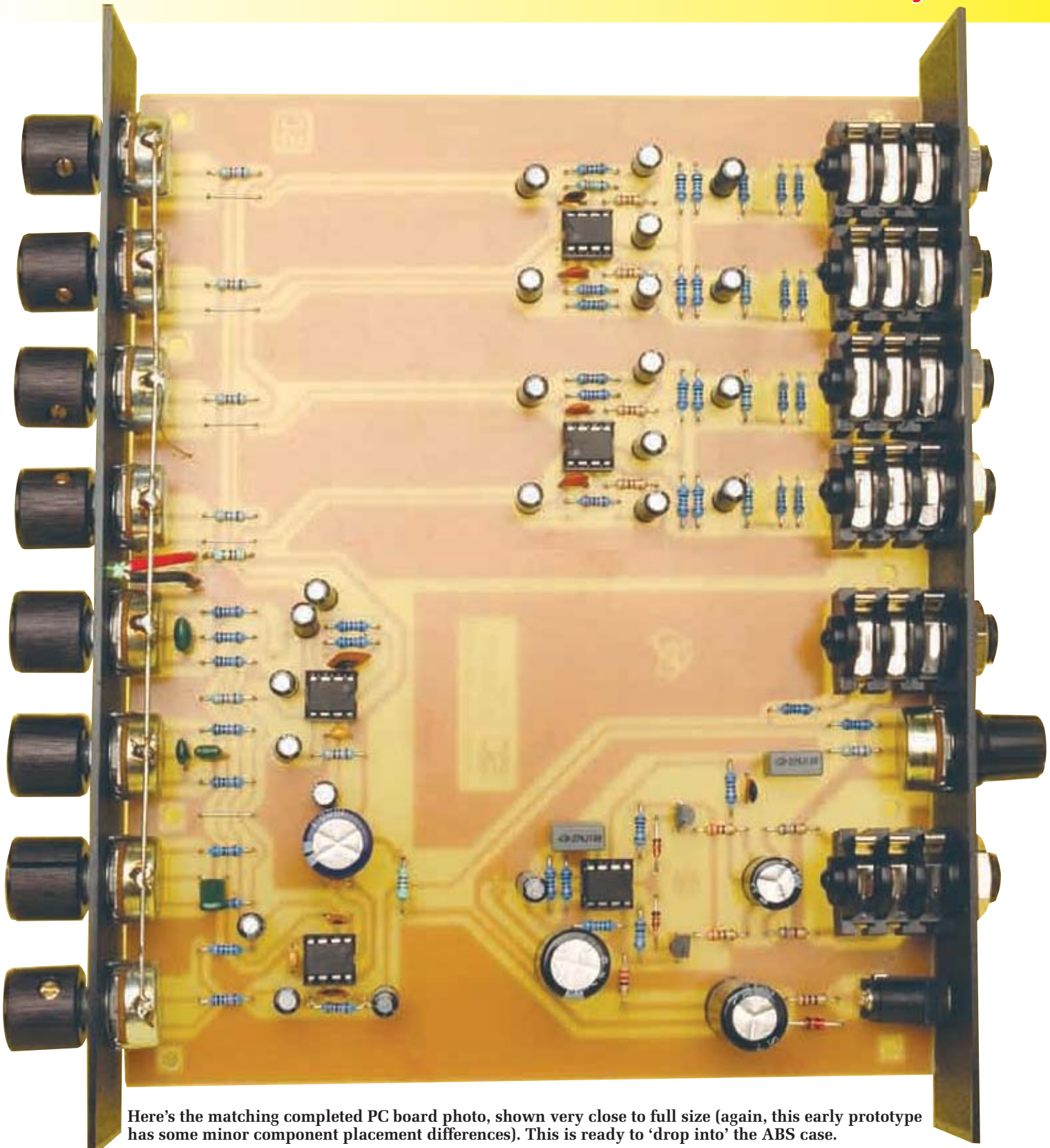
Fig.7: here's how it all goes together. Don't worry about all that PC board real estate with not much on it – the size is basically dictated by the pot spacing and the availability of suitable cases!

solder them together using a 170mm length of tinned copper wire. A second length of tinned copper wire is then used to connect VR3's body to an adjacent earth point on the PC board – see Fig.7. This step earths the pot bodies to prevent hand capacitance effects as the controls are adjusted.

The seven 6.35mm jack sockets CON1 to CON7 can now be fitted along the rear in much the same way, except there is no earth wire to be soldered on.

Once the sockets have all been fitted, the next step is to attach the rear panel to them (and to VR9). This simply involves passing the threaded ferrules through their matching panel holes and then fitting the washers and nuts. Don't tighten the nuts fully yet though – just leave them 'finger tight' for the time being.

The front panel is fitted in exactly the same way, this time over the threaded ferrules of VR1 to VR8. Again, leave the pot nuts finger tight – they're not fully tightened until the assembly is fitted into the case.



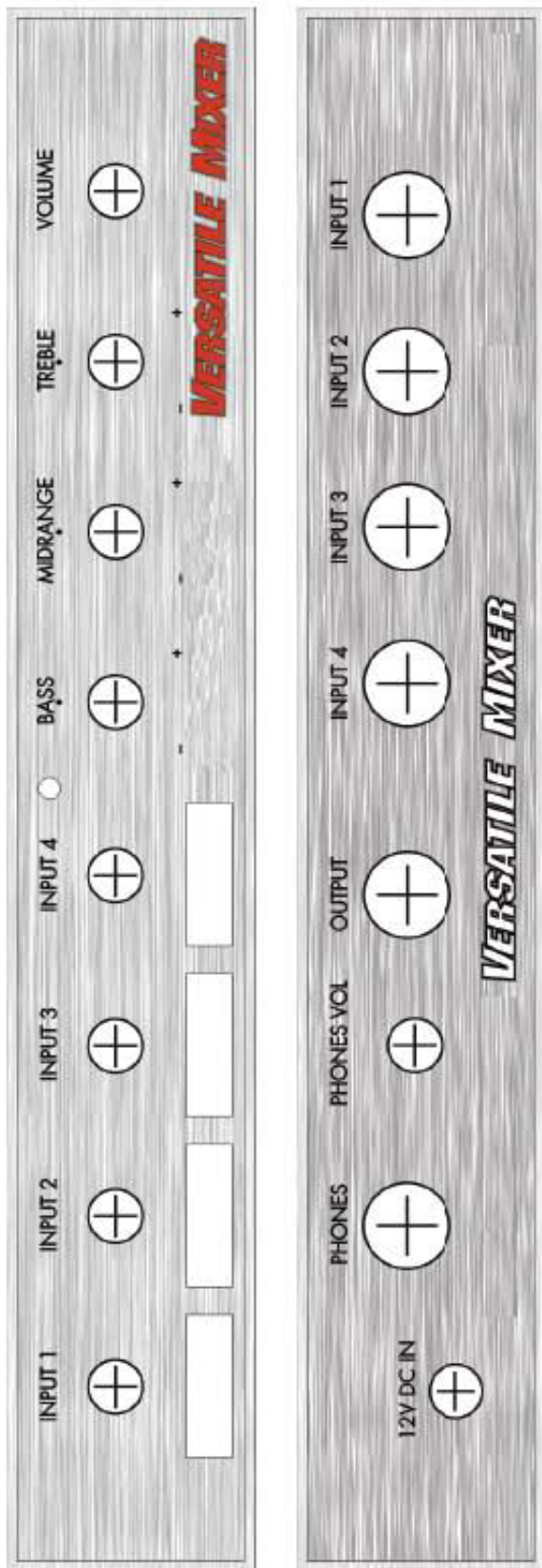
Here's the matching completed PC board photo, shown very close to full size (again, this early prototype has some minor component placement differences). This is ready to 'drop into' the ABS case.

Once this has been done, you're now ready to slide the completed board/panel assembly down into the lower half of the case, with the panel ends mating with the front and rear case slots. That done, the PC board can be fastened to the integral standoffs on the base of the case using nine of the small self-tapping screws provided.

The connector and pot mounting nuts can now all be carefully tightened with a small spanner. Don't tighten them too forcefully

though, otherwise you'll strip their threads. Just nip them up tight enough to ensure they don't loosen with use. That done, you can fit the control knobs to the pot spindles.

The 'power on' LED mounts so its front is flush with the front panel – a tiny dab of super glue is enough to hold it in place. The LED leads will probably not be long enough to reach down to their respective holes on the PC board, so use some resistor lead cut-offs to lengthen them.



Front (left) and rear panels for the Versatile Mixer. The white panels underneath each input pot are used for writing on the input source (using a fine felt-tipped pen) – especially if your mixer is not permanently installed (and even if it is). Instantly knowing which input is which can save a lot of embarrassment when you need to adjust levels.

If there is any danger of shorting the LED leads to the potentiometer earthing wire, you can slip some short lengths of insulation over the leads.

There's now just one more step to complete the construction and that's to plug the five ICs into their sockets. Be sure to fit the LM358 into the IC5 position and take care to ensure that they are correctly orientated (IC1 and IC2 face in one direction, while IC3, IC4 and IC5 face in the opposite direction).

Checking it out

There are no circuit adjustments to be made, but you should give it a quick visual check-out to make sure everything is in the right place and you haven't, for example, put any of the ICs, other semiconductors or electrolytic capacitors in back-to-front.

If it all checks out, you should make a simple current check before pronouncing it ready for use. This is easy to do – you actually do it by measuring voltage!

First, turn control pots VR1 to VR4, VR8 and VR9 fully anticlockwise and set VR5 to VR7 to the centre of their ranges (ie, at the top).

That done, connect a 12V DC power supply to the mixer's power socket. Make sure the power supply plug's centre pin is positive, otherwise the 10 Ω resistor will let its smoke out and the mixer will definitely not work.

Now turn on the power supply and make sure the front panel LED comes on. That's a pretty good clue that everything is working properly. But it's not foolproof!

Set your multimeter to its lowest voltage range, and connect it across the 10 Ω resistor at the DC input socket on the PC board. It should read somewhere between 200mV and 300mV (200mV across the 10 Ω resistor means that the mixer is drawing 20mA).

If so, you can be reasonably confident your mixer is working properly. However, if the reading is higher than 300mV, switch off immediately because this indicates that there's some kind of error. At least you can be assured that it isn't a wiring error because there is no wiring!

So what is wrong?

There are quite a few fault possibilities – you may have connected the DC power lead with reversed polarity, fitted one of the ICs, transistors, diodes or electrolytic capacitors the wrong way around, or accidentally shorted adjacent tracks or pads on the PC board with solder. (Kit suppliers tell us that 99% of problems are due to poor soldering.)

In that case, it's a matter of going over your work and carefully checking everything until you find the problem.

As we mentioned earlier, if you have reversed the power supply polarity, the odds are that the 10 Ω resistor at the input (ie, between the power input socket and the Zener diode) will have said 'too much' and given up the ghost.

Assuming that the voltage across the 10 Ω resistor is correct (at 200-300mV), switch the multimeter to a suitable DC voltage range (eg, 0V to 20V) and use it to check the voltage at various key points in the circuit.

The easiest way to do this is to connect the meter's negative lead to the wire earthing at the pot bodies and then use the positive lead to probe the key voltages. Remember that you have many identical stages to compare voltages.

First, check the voltage at the rear centre pin of CON7 – it should read 12V, or whatever your battery or power supply is delivering. That done, check that pin 8 of either IC4 or IC3 is about 1V lower.

You should also find this voltage at pin 8 of IC1 and IC2 as well. Now check the voltage at pin 8 of IC5. This will be slightly lower again – something like 11.8V or so, if you're using a 12V source.

If everything seems OK so far, check the voltages at pin 7 of IC5 and at pin 7 of IC3. In both cases, you should get a reading of about 5.5V, because these pins are the outputs of the 'half supply rail' splitters. If these voltages are correct as well, your mixer is almost certainly working correctly.

It's just about finished!

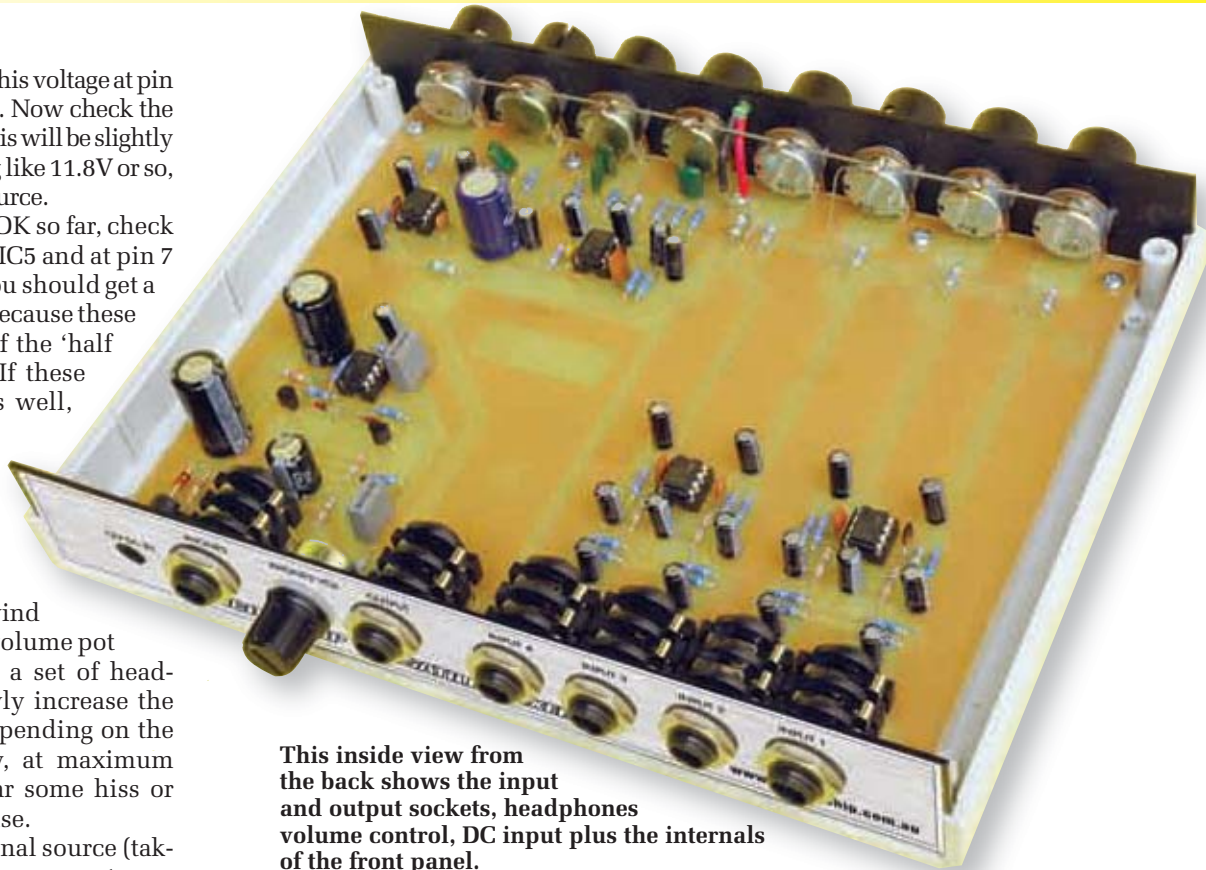
The last check is to wind down the headphone volume pot to minimum, connect a set of headphones and then slowly increase the level to maximum. Depending on the headphone sensitivity, at maximum you will probably hear some hiss or noise, but not much else.

Plug in a suitable signal source (taking into account what components you have selected for the various inputs) and make sure that the input level pot for that source varies the level from zero to maximum.

Check all four inputs in a similar way with other audio sources and also make sure that there is an output at the output socket by connecting it to an amplifier.

All that remains is to fit the top half of the case and fasten everything together using the four countersink machine screws supplied. Your mixer is now complete and ready for use. **EPE**

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This inside view from the back shows the input and output sockets, headphones volume control, DC input plus the internals of the front panel.

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
□ 2	330kΩ	orange orange yellow brown	orange orange black orange brown
□ 4	100kΩ	brown black yellow brown	brown black black orange brown
□ 7	47kΩ	yellow violet orange brown	yellow violet black red brown
□ 8	10kΩ	brown black orange brown	brown black black red brown
□ 2	6.8kΩ	blue grey red brown	blue grey black brown brown
□ 1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
□ 4	1.2kΩ	brown red red brown	brown red black brown brown
□ 4	1kΩ	brown black red brown	brown black black brown brown
□ 2	470Ω	yellow violet brown brown	yellow violet black black brown
□ 1	100Ω	brown black brown brown	brown black black black brown
□ 2	68Ω	blue grey black brown	blue grey black gold brown
□ 3	33Ω	orange orange brown brown	orange orange black gold brown
□ 1	10Ω	brown black black brown	brown black black gold brown

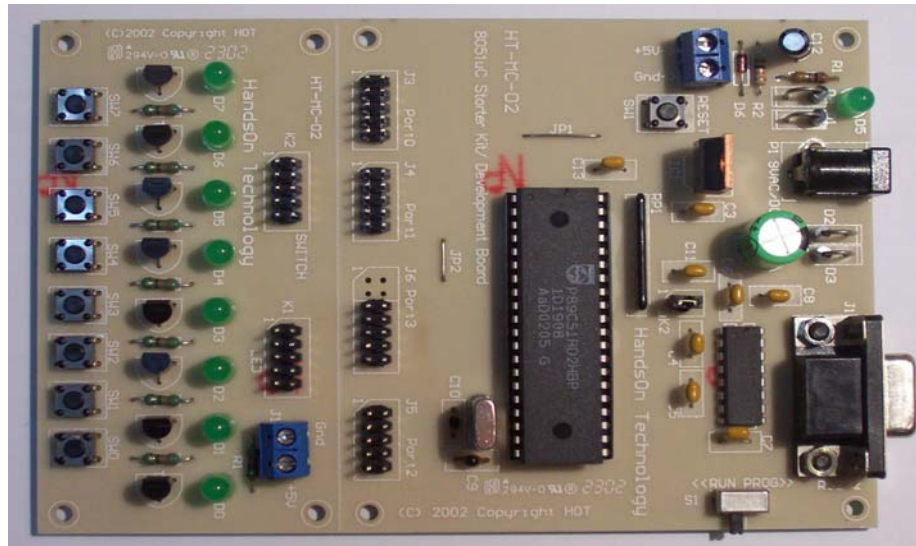
Capacitor Codes

Value	μF code	EIA Code	IEC Code
270nF	0.27μF	274	270n
100nF	0.1μF	104	100n
22nF	.022μF	223	22n
10nF	.01μF	103	10n
2.2nF	.0022μF	222	2n2
1.5nF	.0015μF	152	1n5
68pF	NA	68	68p
39pF	NA	39	39p
22pF	NA	22	22p
4.7pF	NA	4.7	4p7



Low Cost 8051 μ C Starter Kit/ Development Board HT-MC-02

HT-MC-02 is an ideal platform for small to medium scale embedded systems development and quick 8051 embedded design prototyping. **HT-MC-02** can be used as stand-alone 8051 μ C Flash programmer or as a development, prototyping and educational platform



Main Features:

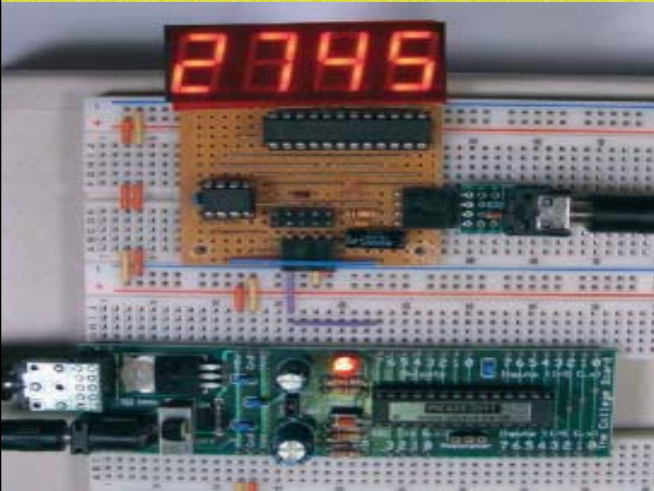
- 8051 Central Processing Unit.
- On-chip Flash Program Memory with In-System Programming (ISP) and In Application Programming (IAP) capability.
- Boot ROM contains low level Flash programming routines for downloading code via the RS232.
- Flash memory reliably stores program code even after 10,000 erase and program cycles.
- 10-year minimum data retention.
- Programmable security for the code in the Flash. The security feature protects against software piracy and prevents the contents of the Flash from being read.
- 4 level priority interrupt & 7 interrupt sources.
- 32 general purpose I/O pins connected to 10pins header connectors for easy I/O pins access.
- Full-duplex enhanced UART – Framing error detection Automatic address recognition.
- Programmable Counter Array (PCA) & Pulse Width Modulation (PWM).
- Three 16-bits timer/event counters.
- AC/DC (9~12V) power supply – easily available from wall socket power adapter.
- On board stabilized +5Vdc for other external interface circuit power supply.
- Included 8x LEDs and pushbuttons test board (free with **HT-MC-02** while stock last) for fast simple code testing.
- Industrial popular window **Keil C** compiler and assembler included (Eval. version).
- Free **Flash Magic** Windows software for easy program code down loading.

PLEASE READ **HT-MC-02 GETTING STARTED MANUAL** BEFORE OPERATE THIS BOARD
INSTALL **ACROBAT READER (AcrobatReader705 Application)** TO OPEN AND PRINT ALL DOCUMENTS

HandsOn Technology

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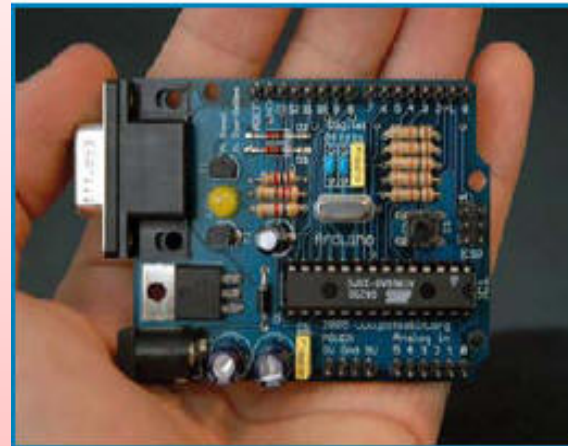
HandsOn Technology is a manufacturer of high quality educational and professional electronics kits and modules, uController development/evaluation boards. Inside you will find Electronic Kits and fully assembled and tested Modules for all skill levels. Please check back with us regularly as we will be adding many new kits and products to the site in the near future.

Do you want to stay up to date with electronics and computer technology? Always looking for useful hints, tips and interesting offers?

Inspiration and goals...

HandsOn Technology provides a multimedia and interactive platform for everyone interested in electronics. From beginner to diehard, from student to lecturer... Information, education, inspiration and entertainment. Analog and digital; practical and theoretical; software and hardware...

HandsOn Technology provides Designs, ideas and solutions for today's engineers and electronics hobbyists.

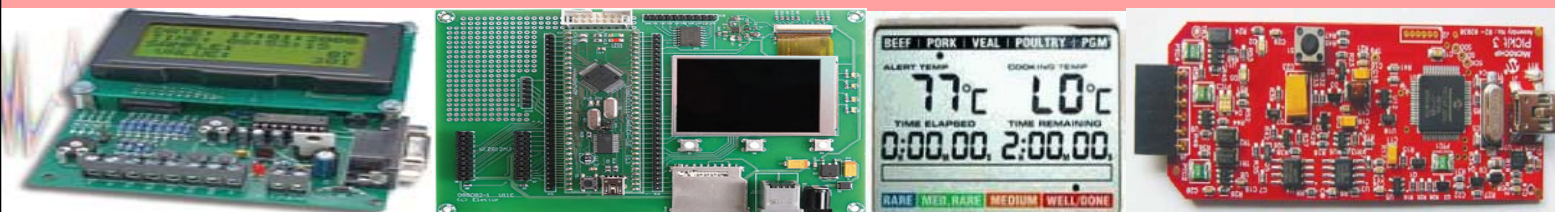


Creativity for tomorrow's better living...

HandsOn Technology believes everyone should have the tools, hardware, and resources to play with cool electronic gadgetry. HandsOn Technology's goal is to get our "hands On" current technology and information and pass it on to you! We set out to make finding the parts and information you need easier, more intuitive, and affordable so you can create your awesome projects. By getting technology in your hands, we think everyone is better off

We here at HandsOn like to think that we exist in the same group as our customers >> curious students, engineers, prototypers, and hobbyists who love to create and share. We are snowboarders and rock-climbers, painters and musicians, engineers and writers - but we all have one thing in common...we love electronics! We want to use electronics to make art projects, gadgets, and robots. We live, eat, and breathe this stuff!!

If you have more questions, go ahead and poke around the website, or send an email to sales@handsontec.com. And as always, feel free to let your geek shine - around here, we encourage it...



<http://www.handsontec.com>