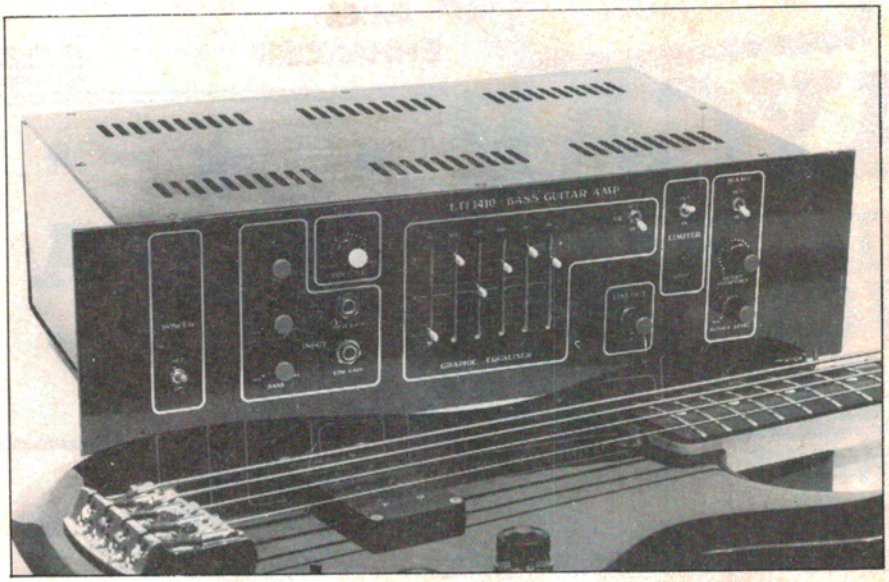
150W BASS GUITAR AMP

Robert Irwin



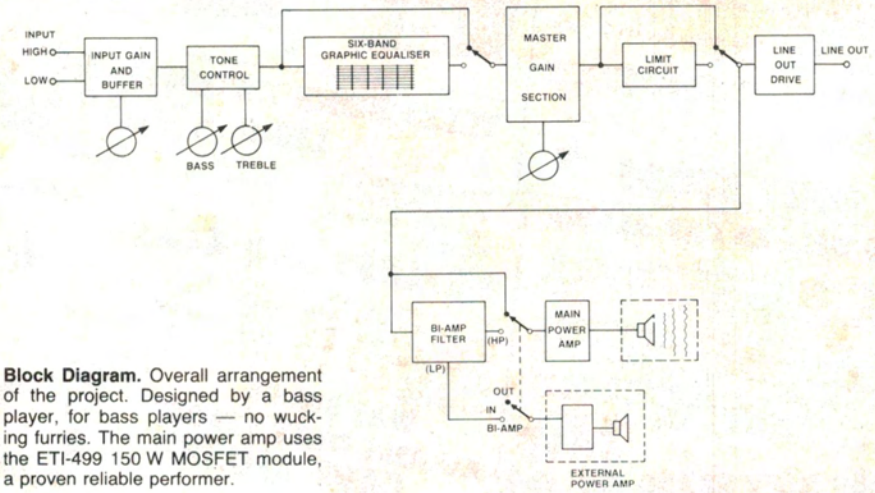
This guitar amp for impecunious bass players features many facilities found on expensive 'bought' ones. It delivers 150 watts into 4 ohms, has a 6-band graphic, limiter, line out and bi-amp facilities.

THERE HAVE BEEN many requests over the years from the growing numbers of build-it-yourself musicians for some good quality musical projects, particularly for stage amps of various descriptions. In the past, ETI has published some excellent power amp designs such as the old faithful '480 module, and in more recent times the '490 MOSFET module. Both of these amps are very suitable as the driver stage in a guitar or keyboard stage amp but, up until now, there have been no designs published for really suitable preamp stages to go with them. This has meant that these power modules have been primarily used in PA applications where they have been driven from a mixer or small mixing preamp.

This project describes a complete 150 W bass guitar amp using the ETI-499 MOSFET power amp module. The amp is housed in a standard 19″ rack-mount case which allows it to be dropped into a standard wooden road case or mounted in an amp rack. The preamp contains features ▶

FEATURES — ETI-1410 BASS GUITAR AMP

- 150 W RMS output into 4 ohms using the renowned ETI-499 MOSFET module
- High gain and low gain inputs
- 6-band graphic equaliser; 50, 100, 250, 500, 1k and 3k Hertz
- Line output facility
- Bi-amp facility
- Output limiter to avoid power amp overdrive
- Housed in a standard 19″ rack-mount case.



Block Diagram. Overall arrangement of the project. Designed by a bass player, for bass players — no wucking furries. The main power amp uses the ETI-499 150 W MOSFET module, a proven reliable performer.

HOW IT WORKS — ETI 1410

This article describes the design and construction of the preamp, equaliser, and 12 V power supply sections of the Bass Guitar Amp, so only these three items are covered here. The other sections are covered in Part 2.

ETI-1410a PREAMP

This is the input board. It comprises three main sections. IC3 is a 5534 op-amp configured as an inverting amplifier stage. The gain is dependent on which input is chosen. If the LOW GAIN input is chosen, then the gain is given by −R5/R3, which two for the values shown. If the HIGH GAIN input is chosen, then the gain is given by −R5/R4, which is −10 (i.e. ×10 inverted, for the values shown.

The gain of this stage may be altered by changing resistors R3, R4 or R5 and can be tailored to suit different input levels. It should be noted however, that if the gain is increased by any great amount (say, to 20), then it would require only a few hundred millivolts to saturate the input amp and drive it into clipping. Therefore, it is recommended that, unless the expected input signal is only a few hundred millivolts, the input stage gain should be left at unity. Also, the input resistance is set by the parallel combination of R1 and R3 for the LOW GAIN input, and R2/R4 for the HIGH GAIN input. These should be kept above about

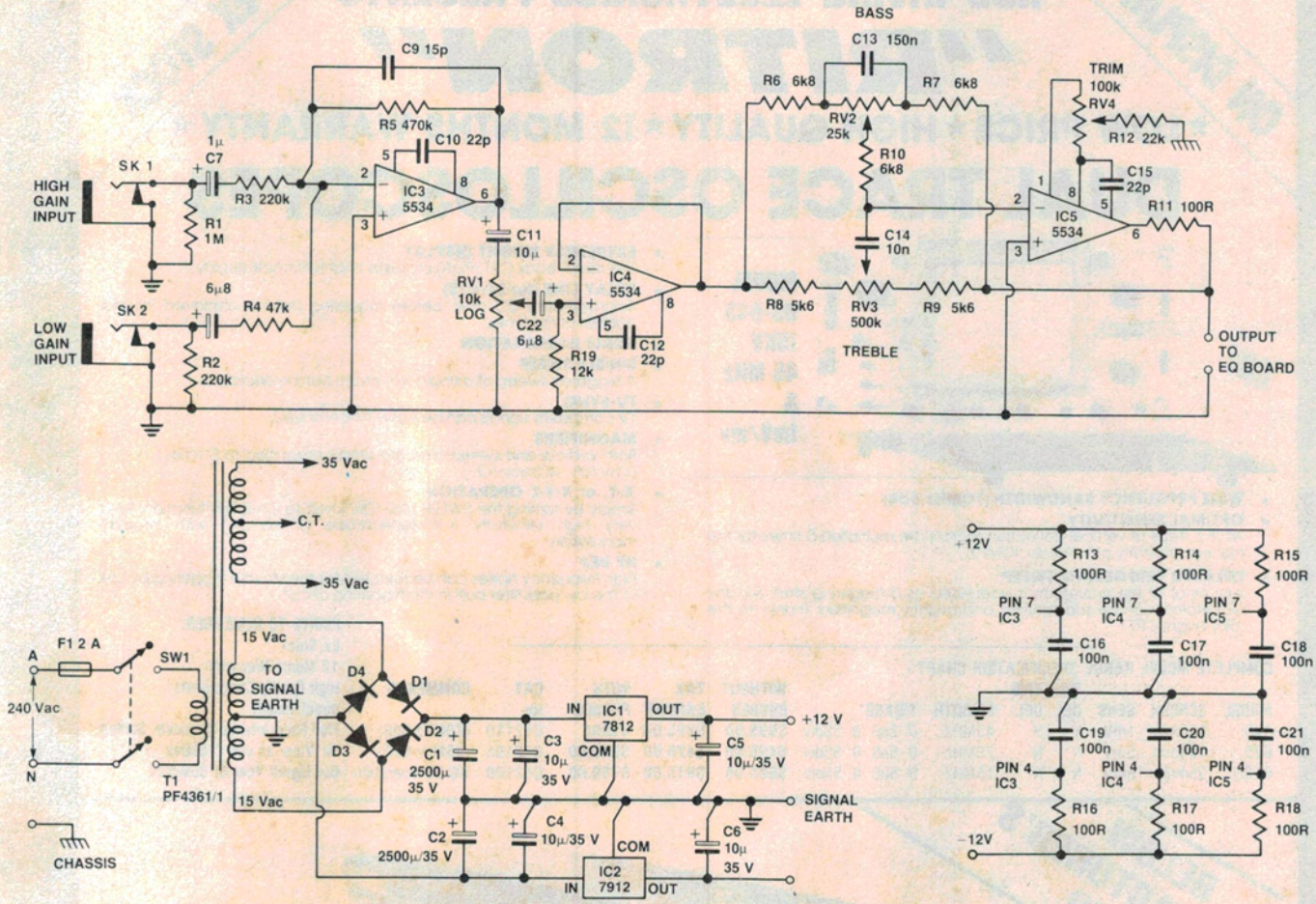


Figure 1. Tone control at low frequencies.

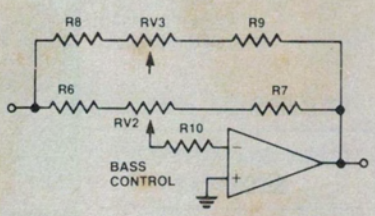


Figure 2. Tone control at high frequencies.

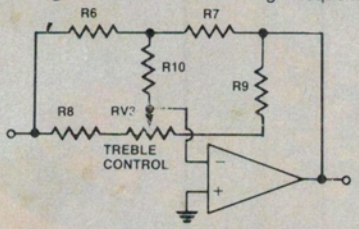
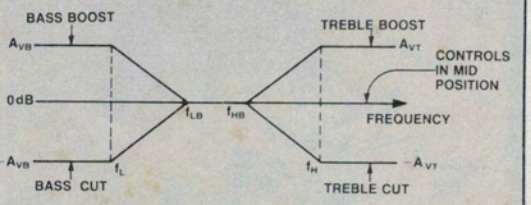


Figure 3. Bode plot of tone control circuit behaviour.



30k or so to give minimum loading to the bass pickups.

The input is ac-coupled via C7 or C8. Resistors R1 and R2 ensure that no charge can build up on the input line due to stray capacitances.

Capacitor C10 compensates IC3 at unity gain. Actually, the value used overcompensates the 5534, but since a very wide bandwidth is not essential in bass applications, it was decided to overcompensate for the greater stability it provides.

The output of IC3 is fed to IC4 via RV1 which provides signal level control. IC4 is a 5534 op-amp configured as a unity gain buffer. This isolates the input section from the tone control network and provides a low impedance drive for that network. Capacitor C12 provides the necessary compensation for IC4.

The tone control network itself is an active 'Baxandall' negative feedback type. Bass control is provided by RV2 and treble control by RV3. To see how it works, let us examine simplified circuits for the high and low frequency operation.

Figure 1 shows the simplified low frequency model. The capacitors become virtual open circuits at low frequency and the gain is dependent on the setting of RV2 only.

Figure 2 shows the equivalent high frequency circuit. This time, the capacitors become virtual short circuits and the gain is dependent on the setting of RV3 only.

The values for the tone control network were found using the equations for this type of circuit derived in the *National Audio Handbook*.

Figure 3 shows a Bode frequency plot for this circuit.

The circuit was designed for $A_{VB} = A_{VT} =$ 14 dB, and $f_L = 40$ Hz, $f_{LB} = 200$ Hz, $f_{HB} =$ 600 Hz and $f_h = 3$ kHz.

The op-amp used is, once again, a 5534. Capacitor C15 provides the compensation for unity gain operation. An offset null adjustment is provided via RV4 and R12. This allows cancellation of any dc offset at the output which could affect the bass control operation and generate noise.

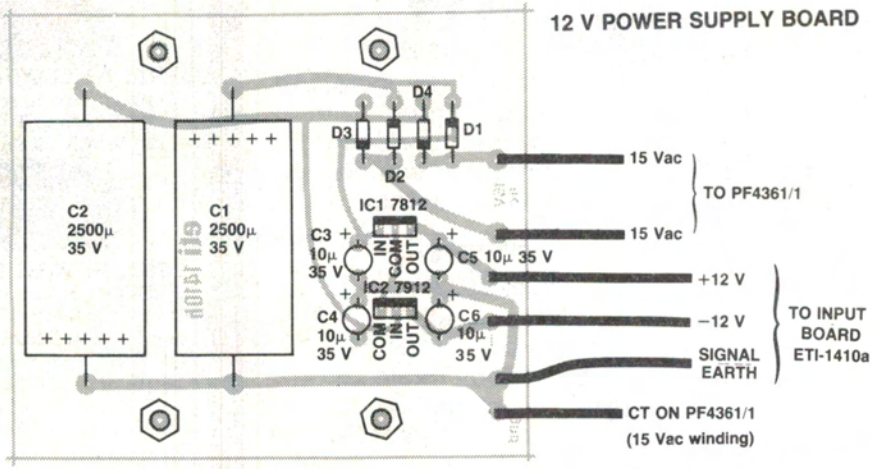
ETI-1410b 12 V POWER SUPPLY

Referring to the circuit diagram, T1 has 15-0-15 Vac which is rectified by diodes D1 to D4. The two diode pairs provide positive and negative outputs which are filtered by capacitors C1 and C2, respectively. This yields two supplies of around +18 V and −18 V or so.

A three-terminal regulator, IC1, produces a regulated +12 V from the +18 V supply. Similarly, another three-terminal regulator, IC2, produces a −12 V output. Capacitors C3 to C6 are necessary for stable operations of the regulators.

The circuit diagram also shows the mains wiring, including the mains input fuse and neon bezel. These components are not mounted on the pc board and are covered in the general constructional details in Part 2.

NOTE: Board artwork is reproduced on page 158.



such as 6-band graphics, limiter, line out and bi-amp facilities, which are usually found on only the more expensive commercial units.

This article details the overall concept and goes into the construction of the input board, the 12 V power supply and the power amp section. Part 2 will complete the project, giving details of the graphic equaliser and limiter/output boards and final assembly. Some options on setting up and using the amp will also be discussed.

It should be noted that, although far cheaper than a comparable commercial unit, this project would cost up to a few hundred dollars to build. Therefore, to avoid seeing some hard earned cash going up in smoke, only you folks with some experience in building electronic projects should attempt this one. If you still want to attempt it but don't have much electronic experience, then perhaps you can find a friend who does and is willing to give a helping hand to a starving muso.

The basic design approach

Several factors must be taken into account in the design of an amp for an electric bass guitar. Firstly, the frequency response. The low E string on a bass is usually tuned to 41 Hz. This means that the highest notes played on the bass will be only around three or four hundred hertz. As well as this, the average bass speaker box (a TL box for instance) will usually have an upper −3 dB cutoff frequency of around 1 kHz. With this in mind, it is important to design the bass and treble and equaliser sections to work in a suitable range. It's no good putting equalisation at 15 kHz since all you'll be equalising will be noise. Taking into account the need to be able to amplify harmonics as well as the fundamental of the notes it was decided to design the amp to work in the range 20 Hz to 5 kHz.

Unlike a normal guitar, a bass is usually amplified 'clean' (i.e: no clipping) and therefore it is important to ensure that there is plenty of "headroom" in the preamp stage. Most modern bass pickups are capable of putting out signal levels of a couple of volts peak (or more if pickups such as EMGs are used). Therefore the gain structure of the preamp should allow this level of input without causing clipping at the input stages. To facilitate the use of a bass with older pickups which may not have as high an output level, low gain and high gain inputs have been provided.

The power amp

The power amp used as the driver section for this amp is the ETI-499 150 W MOSFET power amp module described in the March 1982 issue of ETI. This module was chosen as it is very reliable, reasonably easy to construct and offers excellent performance and stability. The module will delivery 100 W into an 8 ohm load and 150 W into a 4 ohm load. All the components, including the power supply components, are mounted on the one pc board and the pc board mounts directly onto a heatsink.

The circuit of this amp module will not be reprinted in this article and, for the purposes of description, the power amp module will be treated as a 'black box'. For full details of the specifications and circuit of this module see the article in the March 1982 issue of ETI. (Photostats are available from ETI Reader Services for $3).

12 V power supply

The transformer specified for the ETI-499 power amp module (which is also the transformer used in this project) has an auxillary 15-0-15 V winding which is used, in this project, to provide the positive and negative supply rails for the op-amps in the preamp boards.

The power supply board consists of a full-wave diode bridge rectifier which is filtered with two 2500 µF capacitors to form split rails of around 20 V. This is used to power 7812 and 7912 three-terminal regulators to provide the plus and minus 12 V rails used to run the op-amps.

Input board

The input board contains the initial gain control stage and the tone controls. Two inputs are provided which are designed to give maximum gains of 20 dB and 3 dB respectively. The tone controls are of the Baxandall type. These provide bass and treble control works in the region 20 Hz to 200 Hz and the treble control covers 400 Hz and up.

Equaliser board

The equaliser section is designed to provide unity gain with all controls set flat and 14 dB of boost and cut for each equaliser section. The equaliser consists of a series of filters incorporated into the feedback loop of an op-amp. This is based on the Series 5000 1/3-octave graphic equaliser published in the November 1982 issue of ETI. The equaliser has been configured to give centre frequencies of 50, 100, 250, 500, 1 kHz and 3 kHz, a total of six bands.

The output of the equaliser section is fed into a gain section which acts as master volume control with a maximum gain of 34 dB. This will give an overall maximum gain from the preamp of 34 dB or 40 dB depending on the input used. If the bass you are using has high output pickups, such as EMG types, then you may want to decrease this gain so as to get full use from your volume controls.

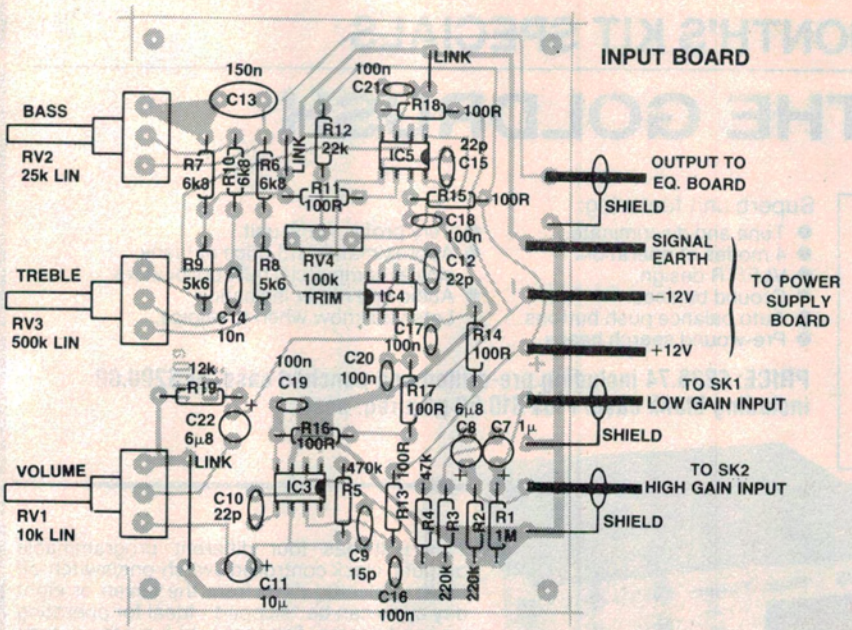
Slider pots are used to control the amount of boost or cut at the equaliser frequencies. These were mounted on a separate pc board which will mount on the front panel of the amp. The only problem you may encounter in this is cutting the slots in the front panel to accommodate the six sliders. This problem will be discussed in 'Constructional details' section in Part

Limiter/output board

This board contains several sections of the circuitry. Firstly, a limiter circuit. This uses an NE570 IC compander. Its function is to limit the output of the preamp to a maximum of 1 V RMS which means that large transients, such as occur when a bass string is struck hard, will not over-drive the power amp and cause unwanted clipping.

The output section of the board provides the drive stages for a line level output which can be used to feed a mixer or for recording. A state-variable filter is used to provide high-pass and low-pass outputs with the cutoffs variable from about 50 Hz to a few hundred Hertz. These outputs are used in the bi-amping facility which allows the use of an external power amp to drive a speaker covering the low frequency end of the spectrum. The internal power amp is then fed from the high-pass filter and amplifies the higher frequencies only.

Level controls are provided for the line and bi-amp outputs to enable matching of the signal levels to the equipment they're driving.



The output facilities provided on this board make the amp very versatile and easily expandable into a large, higher-powered system if 150 watts doesn't hurt your ears enough.

Construction of the pc boards

All of the boards are relatively easy to construct. First, however, check the boards to see that all holes are correctly drilled and that there are no broken tracks or 'bridges' between closely-spaced tracks. Start with the 12 V power supply board (ETI-1410a). Solder in the big electrolytic capacitors (C1 and C2) followed by four tantalum caps. Make sure that you get the correct orientation of these capacitors as they are all polarised and tend to fail rather spectacularly if inserted the wrong way round.

Next, solder the diodes in place followed by the two voltage regulators, IC1 and IC2. These too are polarised and must be placed the correct way round. It is advisable to use solder pegs on the lead connections to this board since several leads may need to be soldered to the same point.

Tackle the input board next. Start by locating and soldering the small link wires in place. Solder in all the resistors and capacitors next. Note that RV1, RV2 and RV3 are specified as the miniature pc mount type with the standard size shaft. These will sit directly on the pc board and are soldered in place. Standard pots can be used but these will have to be attached to the board with hookup wire and, since the prototype board was held on the front panel by the miniature pots, an alternative board mounting scheme would have to be used. The only thing that remains to be done on this board is the mounting of the ICs, one transistor and diode.

The use of IC sockets is not recommended when mounting audio ICs since the stray resistances and capacitances associated may affect the performance of the circuit. For this reason it is very important to put them in the right way round first time. It can be a real pain in the thumb to go round de-soldering ICs if a mistake is made. This then completes the construction of the input board.

The board left to construct at this stage is the main power amp board. As previously mentioned, this is the ETI-499 MOSFET power module which was described in the March 1982 issue. This should be constructed as shown in the original article (with the omission of the large heatsink since a different one is used in this project). If you are one of the very few people who do not have every copy of ETI ever published, then you can obtain a photocopy of the article by writing to our general enquiries service as detailed on page 3 of this issue.

Once all the boards have been completed a thorough check should be made to ensure that there are no small solder bridges between tracks on any of the boards and that all ICs and any other polarised components are mounted the correct way round. This then, completes the first part of the construction of the bass amp.

Next Part

In Part 2 of this article, the details of the final board (the limiter/output circuits) will be given as well as full constructional details, wiring diagrams and front panel artwork. For those experimenters out there, a few optional circuit ideas will be discussed which could be incorporated into the amp if you're after some super-deluxe features. ●

PARTS LIST — ETI-1410a PREAMP

Resistors ..... all ¼W, 5% unless noted
- R1 ..... 1M
- R2, 3 ..... 220k
- R4 ..... 47k
- R5 ..... 470k
- R6, 7, 10 ..... 6k8
- R8, R9 ..... 5k6
- R12 ..... 22k
- R11, 13, 14, 15, 16, 17, 18 ..... 100R
- R19 ..... 12k
- RV1 ..... 10k/C rotary pot (Soanar V16L)
- RV2 ..... 25k/A rotary pot (Soanar V16L)
- RV3 ..... 500k/A rotary pot (Soanar V16L)
- RV4 ..... 100k min trimpot

Capacitors
- C7 ..... 1µ/10 V tant
- C8, C22 ..... 6µ8/10 V tant
- C9 ..... 15p ceramic
- C10, 12, 15 ..... 22p ceramic
- C11 ..... 10µ tant
- C13 ..... 150n greencap
- C14 ..... 10n ceramic
- C16, 17, 18, 19, 20, 21 ..... 100n ceramic bypass

Semiconductors
- IC3, 4, 5 ..... NE5534N, LM5534N

Miscellaneous
- SK1, SK2 ..... 6.5 mm insulated, earthing-type, panel-mount mono jack sockets.

ETI-1410a pc board; hookup wire.

Price estimate: $17-$20

PARTS LIST — ETI 1410b ±12 V SUPPLY

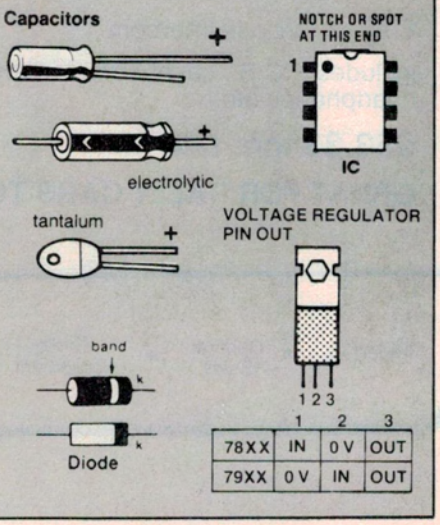
Capacitors
- C1, C2 ..... 2500µ/35 V axial electros
- C3, 4, 5, 6 ..... 10µ/35 V tant

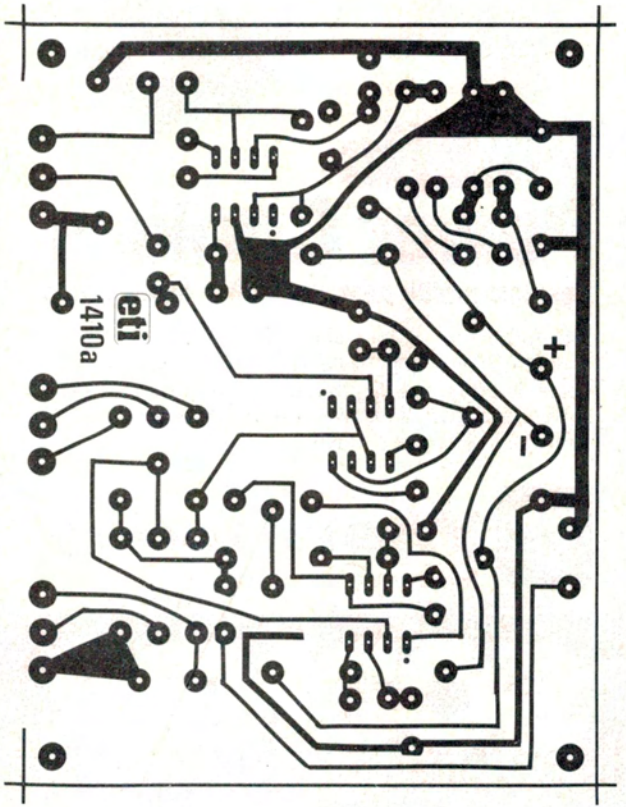
Semiconductors
- D1-D4 ..... 1N4001, 1N4002, etc
- IC1 ..... µA7812, LM340/T12
- IC2 ..... µA7912, LM7912

Miscellaneous

ETI-1410b pc board; pc pins; hookup wire (T1 is the main transformer, the HT secondary of which supplies the power amp section of the project — see Part 2).

Price Estimate: $12-$14

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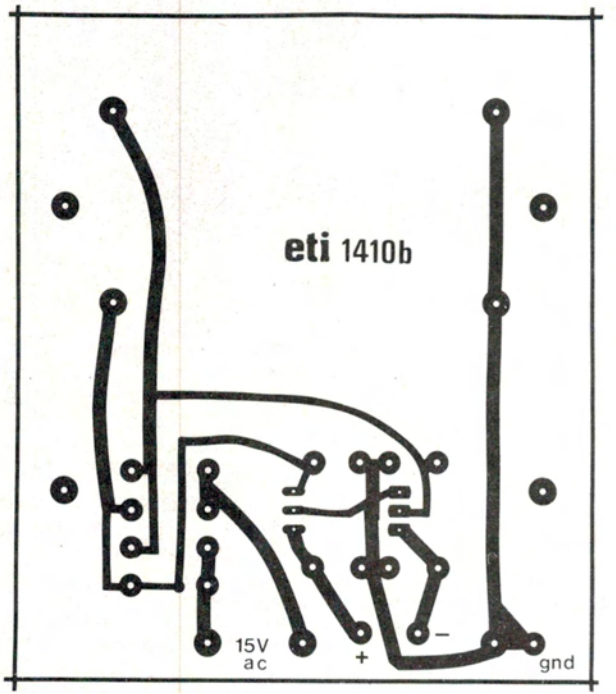
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