# LED audio peak programme display

A 'universal' audio peak signal display, this simple project is cheap and easy to build. It features a 10-LED bargraph array and has thousands of applications as an add-on to a hi-fi system.

**David Tilbrook**

THIS PROJECT can be installed in any audio system to provide a simple visual indication of signal level either at the output of the preamp or at the output of the power amp. It features a 10-LED bargraph-type display that shows the peak signal level over a 30 dB range with a single moving dot or a varying bar of light.

There are a number of reasons for monitoring signal level in an audio amplifier system. Firstly, using a meter or other signal level monitor, you can set up a desired level and always return to the setting at a later time. Secondly, transients in programme material can easily exceed clipping levels in a preamp or power amp, causing distortion. A power amplifier driven heavily into clipping can deliver near-dc to a speaker, possibly causing damage.

The design of this display is adapted from the ETI-458 LED Level Meter which is used in the Series 5000 preamplifier. The ETI-458 features a simultaneous peak and average display with a row of 20 LEDs giving a 60 dB dynamic range. However, the design is more complicated than required for a general purpose level display and, as the pc board is quite large, it is difficult to install as an add-on to a hi-fi system, a mixer or such like.

A VU meter (VU stands for volume unit) is the generally-used 'work horse' audio level meter. It measures the signal level and displays it in decibels (dB). However, it is slow to respond and indicates something between the average and the real peak of the signal voltage so that all but the most repetitive peaks will be hidden. The VU meter could be indicating that the signal level is −15 dB when the peak transients of the signal are actually overloading the amplifier.

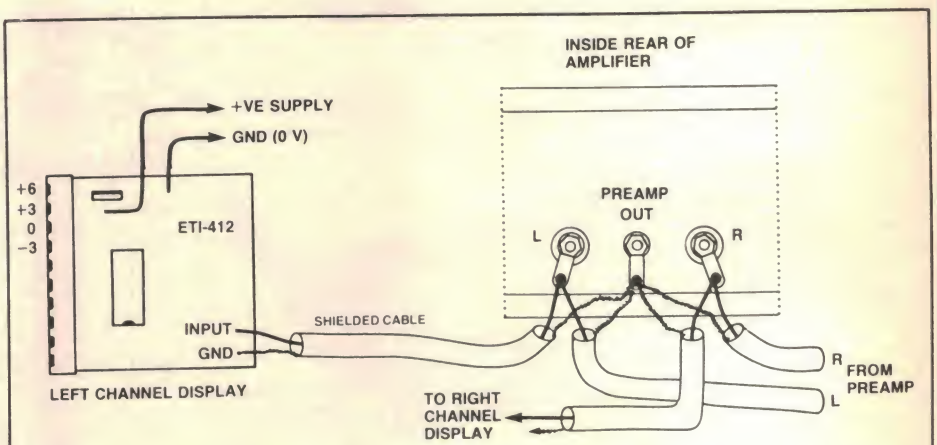



**Figure 1.** The peak programme display can be hooked up to the hi-fi system to monitor the output of the preamplifier.

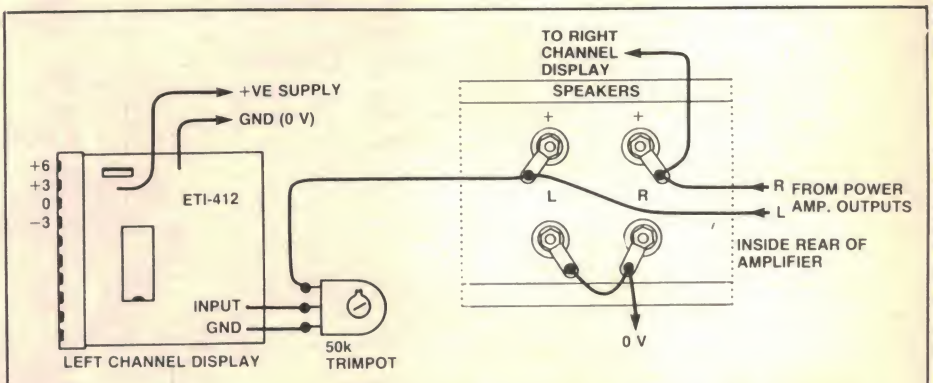
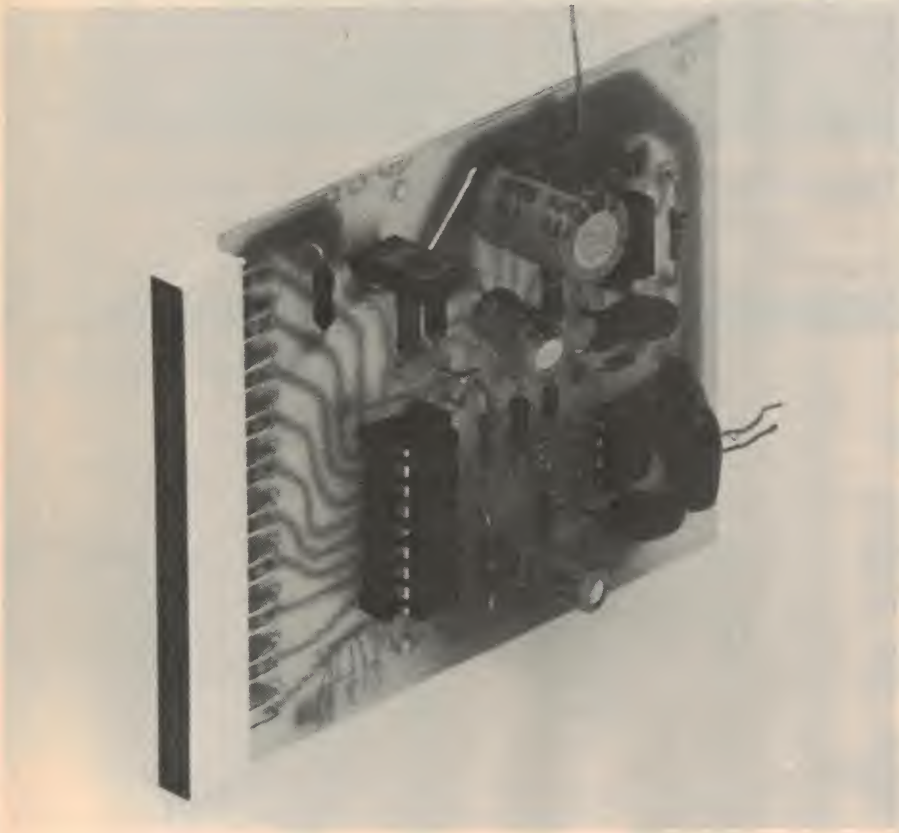



**Figure 2.** When monitoring the output of the power amplifier the display can be set to indicate the rated power output of the amplifier.



The display could also be used to monitor the output of the power amplifier. It could be set so that the 0 dB level on the display indicates the rated power output of the amplifier.

The display will also be useful for setting signal levels when taping. The advantage of using a peak signal indicating meter when tape recording means you can avoid overloading the tape and the consequent distortion.

The LED display has 3 dB between steps but all you need is a visual indication so a continuous scale is not necessary.

When you are wiring up the circuit it can be set for either a bar or dot display. As the circuit is designed it does not have a switch, but you could add a switch to the circuit so that it is possible to switch from bar to dot mode.

The peak rectifier system used in the ETI-458 LED Level Meter is used in this project. The output of the full wave rectifier, IC1, is fed to a peak follower formed by IC2 and its associated components.

The peak follower has a rapid attack/slow decay characteristic so that it responds quickly to any transients but decays slowly so the display 'hangs on' enabling you to see it easily.

The output from the peak follower goes to IC3, LM3915, which is the LED bargraph driver. The output of IC3 drives the 10-LED display. This was supplied by Altronics and we chose it rather than using separate LEDs as it is easier to use and looks better. ▶

Another disadvantage of most VU meters is their limited dynamic range, being only about 20 dB, as it is a linear analogue meter and has a non-linear scale cramped at one end.

The ETI-412 has a logarithmic scale from −21 dB to +6 dB. As the ear responds logarithmically you need a logarithmic response from a meter. A perceived doubling of loudness is actually a 10 dB change in the sound level.

There are several places where this peak programme display can be connected in a hi-fi system but it is usually used to monitor the output of the preamplifier. It can then be set up so the point where the power amplifier commences clipping will be indicated at the top of the scale.

If you know that the headroom of the amplifier is, for example 3 dB, you can set it up so that the peak transients only go up to the +3 dB level on the display. If the volume is so loud that the level is peaking at +6 dB then you know that the amplifier is being driven into clipping. If you don't have a meter to indicate the peak signal level your ears will tell you that something is wrong as the distortion will be very obvious.

If the amplifier is clipping for a significant proportion of the time the speakers may blow up. While it is simpler to just build a clipping indicator, it is also useful to know something of the dynamics of the signal.

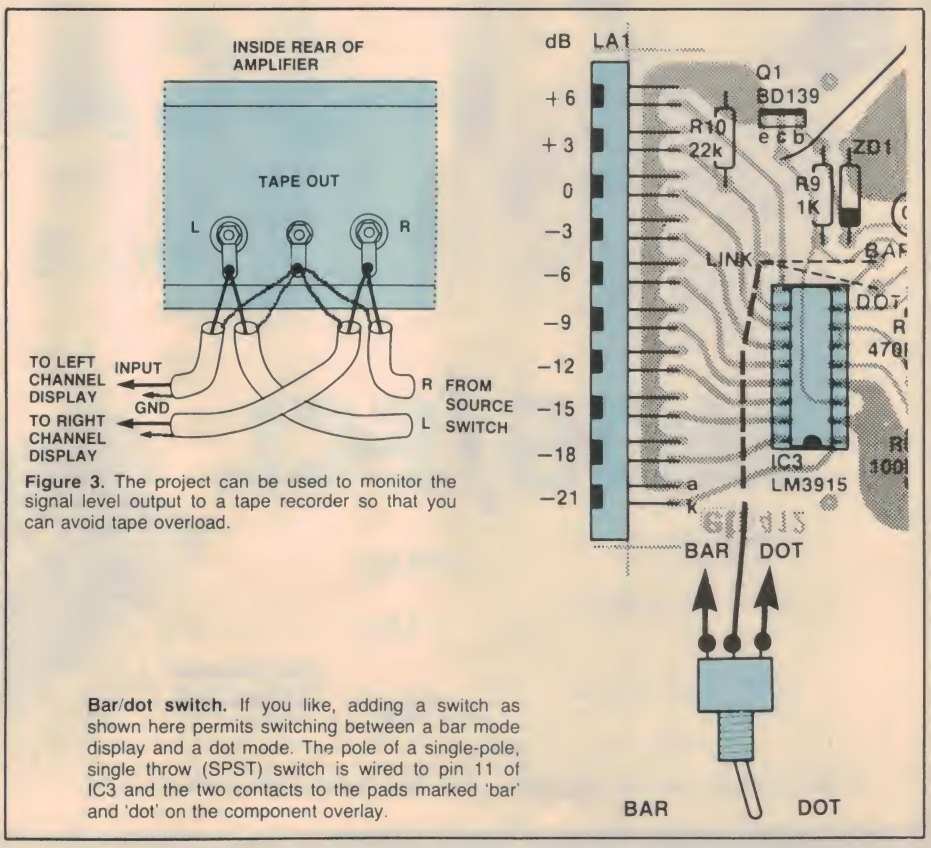
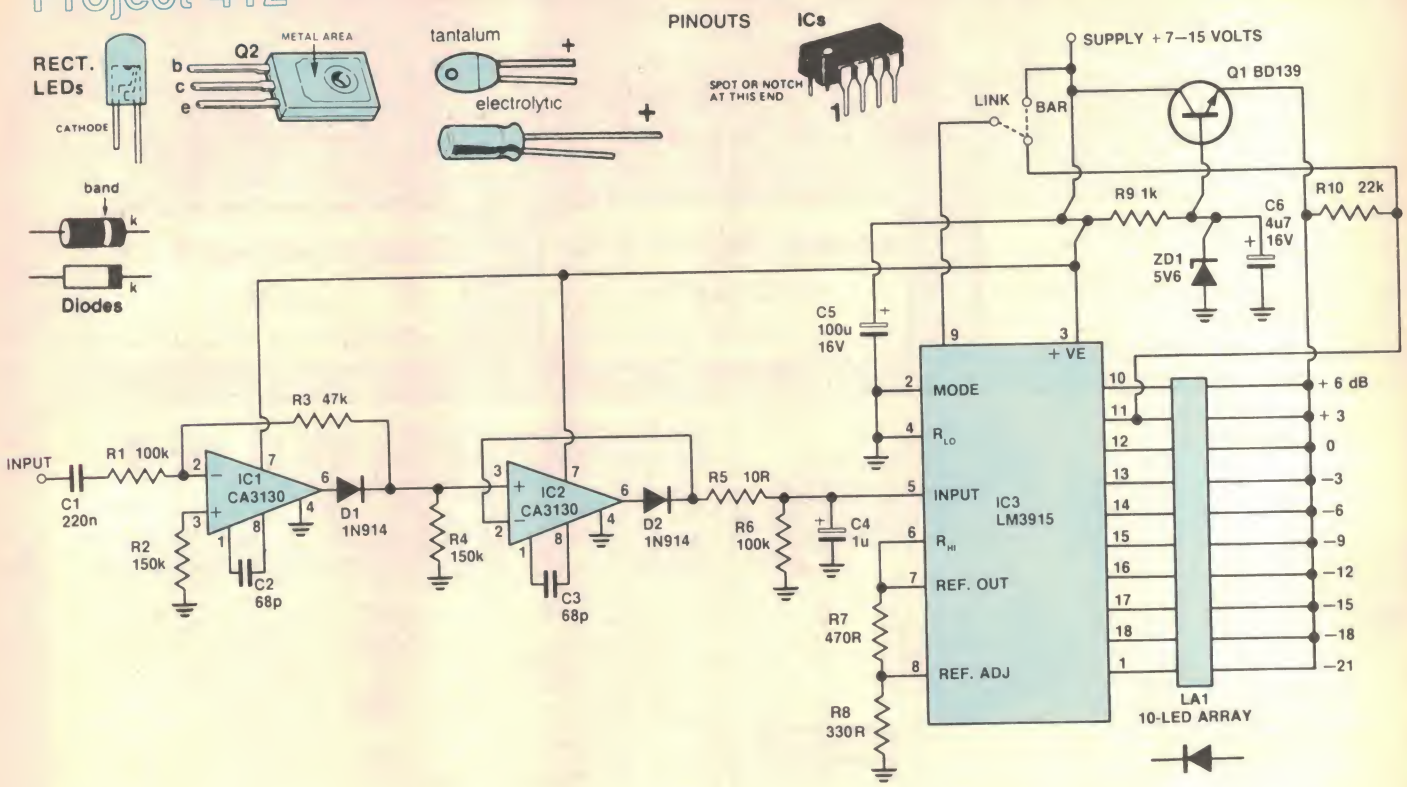



**Figure 3.** The project can be used to monitor the signal level output to a tape recorder so that you can avoid tape overload.

**Bar/dot switch.** If you like, adding a switch as shown here permits switching between a bar mode display and a dot mode. The pole of a single-pole, single throw (SPST) switch is wired to pin 11 of IC3 and the two contacts to the pads marked 'bar' and 'dot' on the component overlay.




## Construction

As you can see from the overlay, the pc board layout is very simple. Before you get carried away with soldering, examine the board very carefully. Regardless of whether you made the pc board yourself or you purchased it, check to make sure that there are no small copper 'bridges' between closely spaced tracks (particularly between IC pins) and no tiny cracks in the tracks. Also make sure that all the holes are drilled correctly.

Those of you who want to use IC sockets in this project can do so.

You can start assembling the pc board by soldering the resistors in place. The three diodes can be soldered in position next, making sure that they are the right way around. If you are using IC sockets then solder them on the board next, otherwise, solder the ICs in next.

Then you can add the transistor BD139 and the capacitors, but check that the three electrolytic capacitors are correctly orientated.

The last thing to work out is which way the LED bargraph goes and solder it in place. The longer leads are the anodes which connect to the single common track along the edge of the board. If you do happen to connect the bargraph back-to-front it is unlikely anything will be damaged when you power it up.

Don't forget to wire up the link for either dot or bar display, depending on what you prefer. If you think that you might like to use either display then you can incorporate a switch into the circuit, as shown in the accompanying diagram.

## HOW IT WORKS — ETI-412

The project is quite simple. There are three stages: a full wave rectifier or 'absolute value generator', a 'peak hold' circuit and a logarithmic display driver. The full wave rectifier produces the absolute positive value of the incoming signal and the peak hold circuit 'pumps up' a capacitor to the peak level, this capacitor only being slowly discharged so that the peak of the incoming signal is 'held' on to. The input of the display driver looks at the signal on the capacitor and drives a 10-LED array, each LED coming on in turn when the display driver's input is twice its previous value (ie: at 3 dB intervals).

The full wave rectifier comprises IC1, D1 and surrounding components. The input signal is coupled to the inverting input of IC1 via C1-R1. With a negative-going input signal, the stage acts as an inverting amplifier with a gain of a half determined by the ratio of R3 to R1. Thus, a positive-going output signal appears at the cathode of D1, half the level of the input.

When the input signal is positive-going, IC1's output is driven hard against its negative supply which is the 0 V rail here. Thus, the op-amp's output stage is turned off and, as it has a relatively high output impedance, and D1 is reverse-biased, the input signal will be just divided down by the potential divider formed by R1, R3 and R4. The voltage across R4 will be half the input voltage as R1 + R3 equals R4.

The signal across R4 is coupled to the non-inverting input of IC2, the peak hold stage. IC2 has a gain of one (unity) and the signal at the cathode of D2 will rapidly charge C4 via R5, a low value resistor. When the signal level on the output of IC2 falls below the voltage on C4, D2 will be reverse-biased and C4 will slowly discharge via R6, 'holding' the signal level on C4 long enough for your eyes to see the appropriate display LED lit.

The LM3915 display driver lights the LEDs at 3 dB intervals, according to the level presented at its input, which is across C4. The sensitivity of IC3 is set so that the 0 dB LED lights with 1 V peak at the input.

A regulated supply of 5 V is provided by a simple zener-referenced series regulator. This comprises Q1, ZD1, C6 and R9. The supply input can be anywhere between +7 V as a minimum and +15 V as a maximum (otherwise dissipation in Q1 becomes excessive).

The LM3915 can be arranged to provide either a 'dot' display, where just a single LED is turned on at a time, or a 'bar' display, where all the LEDs up to the peak are turned on. This is done by linking pin 11 to the positive supply rail for BAR mode or to pin 9, with a 22k bias resistor (R19) going to the +5 V supply, for DOT mode operation.

## PARTS LIST ETI-412

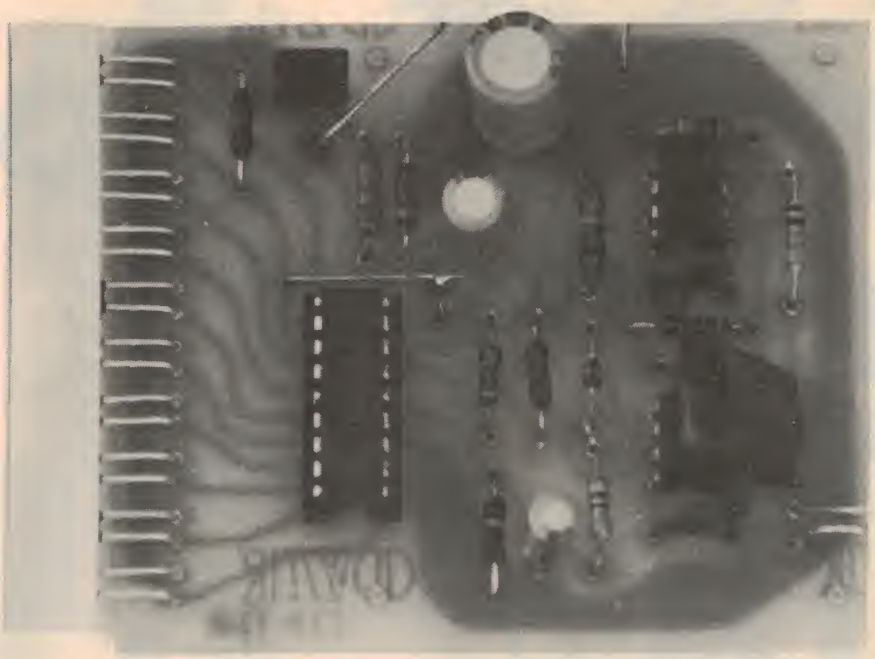
**Resistors**.....all ¼W, 5%
R1, R6.....100k
R2, R4.....150k
R3.....47k
R5.....10R
R7.....470R
R8.....330R
R9.....1k
R10.....22k

**Capacitors**
C1.....220n greencap
C2, C3.....68p ceramic
C4.....1µ/6 V low-leakage (RBLL) electro
C5.....100µ/16 V single-ended electro
C6.....4µ7/16 V single-ended electro

**Semiconductors**
IC1, IC2.....CA3130
IC3.....LM3915
LA1.....10-LED array (Altronics Z-0180)
Q1.....BD139
ZD1.....5V6

**Miscellaneous**
ETI-412 pc board; tinned copper wire.

**Estimated cost: $15-$18**

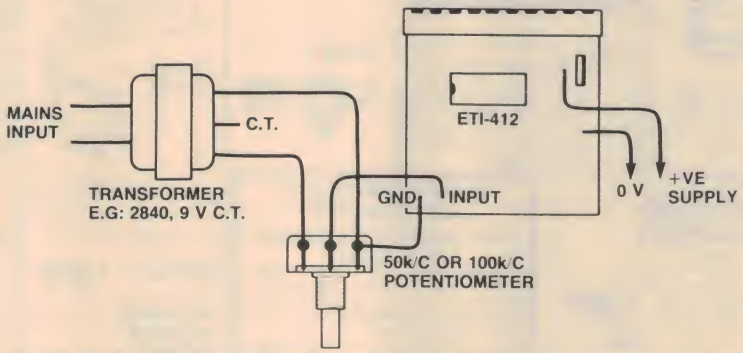


## Testing it

Test this project by attaching it to a +7 −15 V power supply and applying a signal to the input. The input signal can be supplied by an audio signal generator or from the output of a low voltage transformer.

If you are going to use a transformer for this, connect a 100k potentiometer to the output of the transformer with the wiper of the potentiometer connected to the input of the project. If the meter is working properly the display on the LEDs should go up and down as you vary the level.

If the meter does not work at this stage check that all the components have been placed correctly on the board and orientated the right way around. ●




**Test it out first.** Before installing this project in your hi-fi system make sure that it works first in the illustrated test situation.