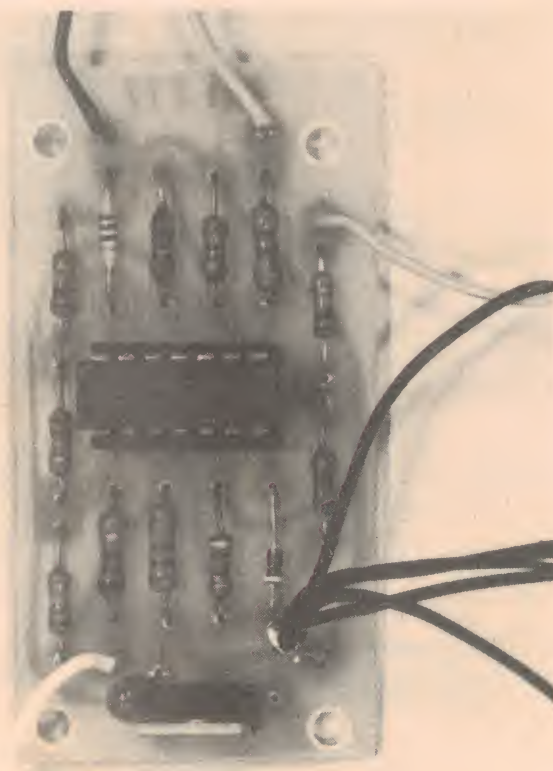# A three-LED power level indicator for audio amps

This simple project provides indication of when your power amp output reaches three pre-determined levels. It's more useful than a simple clipping indicator (your ear is better at that!) and is cheaper and easier to install than bargraph level displays or moving coil meters.

Jonathan Scott

IT HAS BECOME the trend to include some indication of power delivered to the speakers by a power amplifier. This is a basically sensible idea. You have some idea of when you are getting near the limitation of the amplifier or the speakers, or perhaps it tells you whether the power amp is producing signal when trying to find out where the music went. It will even indicate if you are liable to be aggravating the neighbours by shaking their ceiling, assuming you are losing touch with the actual volume delivered, as one does after a long while of high level.

Many amplifiers do not have these facilities, however, my ETI Series 5000 included. (So it doesn't have much to do with actual sound quality.) Some expensive,

up-market power amps come with two calibrated panel meters, which seems to be something of a waste of $40 or so, considering how often you actually need the facility. Some include only a LED 'clipping' indicator which is even less useful if it only warns of clipping, rather than getting close to it, because the ear can report this fairly reliably'.

This project was specifically designed to go in my Series 5000 power amplifier, to allow it to have some output indication while consuming only a minute amount of panel room, of which there is precious little left due to the front panel heatsink design. It sports three LEDs which turn on at power levels of one, eight and 50 watts (into 8 ohms). Should you wish to adjust the

turn-on points to suit a system other than 8 ohms or power levels higher or lower than these, the equations for figuring the correct values to substitute are given in the How It Works section.

The main features of the circuit are that it does not load or interfere with the signal as the unit has a 10k input impedance, it costs very little and takes up very little room inside the case. It is also very flexibly designed, allowing the selection of any set of levels to suit different applications.

Boards can also be cascaded to give six-level readout if desired, simply by running two in parallel and selecting the appropriate resistors to get the desired levels. While I did design it as a retro-fittable addition for my 5000 amplifier, you can install it inside almost any amplifier, even a commercial one if you wish, as it has its own on-board voltage regulator and can run on any suitable filtered dc supply, and consumes little 'backroom' space and so little panel space. It could also come in useful in applications requiring a LED meter whose scale is neither linear nor logarithmic, as these are the functions often implemented in LED meter circuits.

Construction

The construction of the circuit itself is very elementary, and can be undertaken as soon as you have worked out where you are going to mount the pc board and LEDs. You should figure out where you are going to fit the board(s) and drill the appropriate holes for them and the LEDs first. You will find it convenient to use the bare board as a template for locating the mounting bolt holes.

If you are fitting a pair to a Series 5000 amplifier, you will find that they fit neatly in the space behind the power switch, bolting to the aluminium members running from the heatsink/front panel to the rear panel. It is then convenient to use the two spare windings on the adjacent power transformer to power the meters, using the circuit given here, mounting the components on a tag strip attached to one of the mounting bolts.

The six LEDs mount easily in two columns of three above the power switch. After drilling the LED mounting holes you

TRANSFORMER AUX. SECONDARY

TRANSFORMER AUX. SECONDARY CENTRE TAP

~ 15 V   15 V

CHASSIS

2 x 1N4002

0 V

330μ/63 V OR 470μ/63 V

++

+ (20-22 V)

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may wish to dab a little black point on the panel to cover up the exposed metal.

The LEDs are quite good looking and unobtrusive if no mounting circlip is used at all, but rather the bare component inserted in a correct-sized hole painted black. They can be kept in place with a dab of glue on the rear of the LED body.

The pc board can be completed once the drilling is over. Simply insert and solder the components in place as per the overlay diagram. Be sure to get the diode, IC and tantalum capacitor in the right way around. You may delete the regulator from the second board and run the ground and +15 volt connections across from the first board directly.

Mount the boards in the chassis, leaving lengths of hookup wire free to be run to the appropriate places. Connect the LEDs and the power supply lines. Be sure to get these the right way around, or you will almost certainly destroy all the polarised components.

HOW IT WORKS — ETI-272

The circuit consists of a power supply regulator, which acts as the voltage reference as well, an input buffer/full-wave rectifier, and three identical comparator stages each of which drives an LED.

The circuit is designed to run on a single +15 volt supply line, which is generated by an on-board three terminal regulator. It should be noted that the supply regulator may be deleted from subsequent boards if the 15 volts line from the first board is used to directly power others. One 7815 will power four boards easily, though it might need heatsinking if handling more than two. It can also be deleted if a 15 volt supply is available already from the amplifier in which it is mounted.

IC2a and surrounding components form the full-wave rectification (or 'absolute value') circuit. It has an overall gain of 0.27, allowing input peaks of +/−50 volts comfortably. This corresponds to an RMS power level of over 150 watts into 8 Ohms, or double that into 4 Ohms. When the level on the input side of R1 is negative, IC2a drives its output positive in order to maintain the inverting input at zero volts; this arrangement produces a gain of −R2/R1, or −0.27. When the input goes positive, D1 prevents the output of the op-amp from having any effect as the diode is reverse biased. The gain input-to-output of the stage is then R3/(R2+R1), or 0.27 again. Thus, full-wave rectification takes place.

Each of the remaining three op-amps is in an identical configuration. The rectified signal is fed to the non-inverting input of each. The LED connected to the output is driven 'on' when the voltage on the non-inverting input exceeds the voltage on the inverting input. The inverting input is fed with a constant level derived from the supply rail of 15 volts by a resistive divider. Selecting the resistors and hence the division ratio fixes the level at which the LED turns on. The equations for selecting these resistors are given later.

Whenever the instantaneous excursion of the input signal exceeds the appropriately set level the associated LED illuminates. Thus, when the input just peaks above the set level for one LED it just illuminates for a small fraction of the cycle, giving a dim glow. When the signal comfortably exceeds the set level the LED remains on for a large fraction, giving a bright glow. The effect on the set of LEDs gives an impression of more than three discrete levels due to the analogue action appearance of the LED response. Because of this, three LEDs at carefully selected levels gives a very informative readout of amplifier activity.

In order to select the resistors associated with each comparator use the following formulae, as in the example below:

$$V_{on} = 15(R5/[R4+R5])/0.27$$

where V_{on} is the voltage at the input required to turn on LED 1.

Similar formulae are applicable for LEDs 2 and 3.

Because Power = V^2/R, (V in Volts RMS) the peak voltage associated with an RMS power level in the loudspeaker of R ohms nominal is given by:

$$V_{peak} = \surd(2PR)$$

Thus, the values of 1k2 and 15k for R5 and R4 give $V_{on} = 4.12$ and this is within 3% of the value of V_{peak} for 1 watt into 8 Ohms.
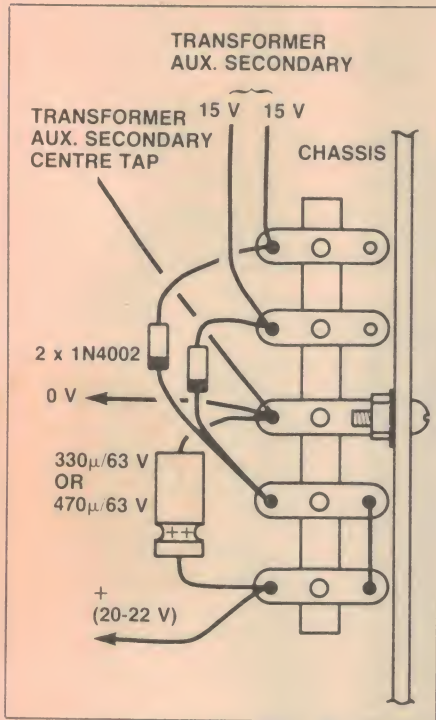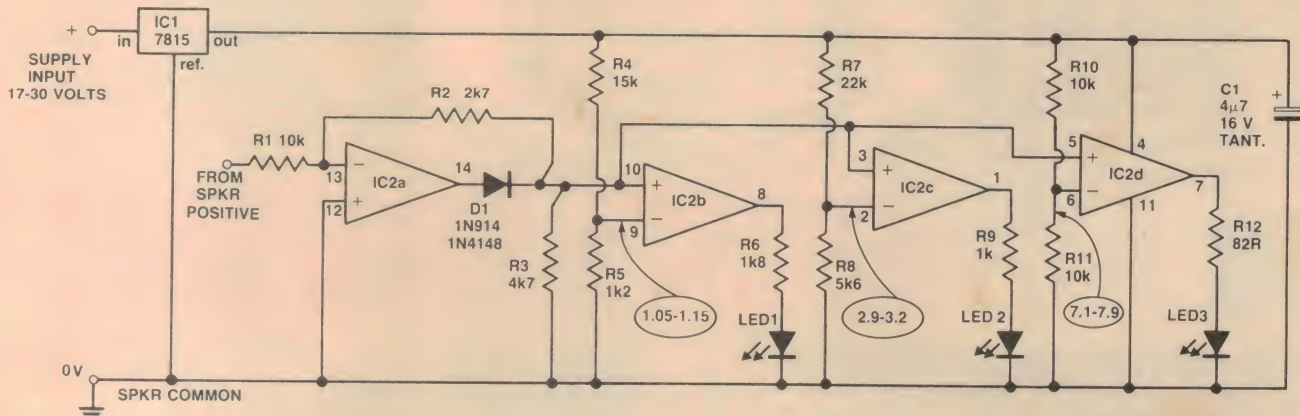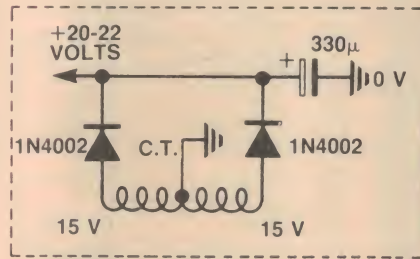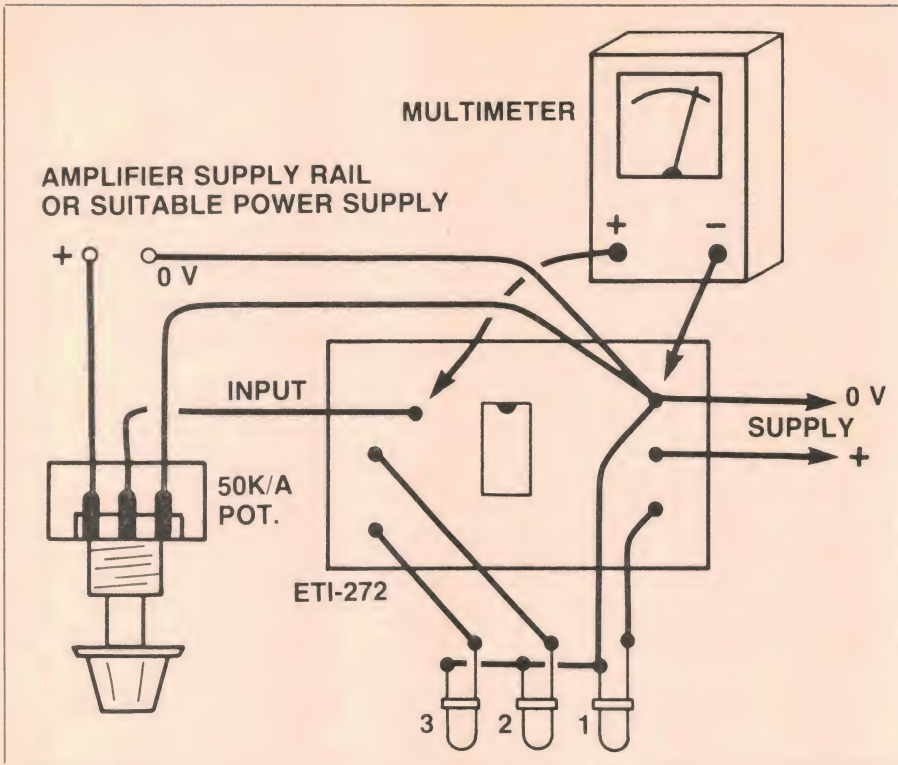
To select resistors to give a reading of ½ watt into 4 Ohms

$$V_{peak} = \surd 2 \times \frac{1}{2} \times 4 = 2$$

then choosing 10k for R4 we get that R5 should be about 375 Ohms; 390 is the closest, being about 4% off.

Those values could be used as R7/R8 or R10/R11 equally well.

Finally, the current limiting resistors in series with the LEDs chosen are not equal. This is in order to give rather more maximum possible brilliance to the LEDs corresponding to higher power levels. Any resistor less than a few hundred ohms will not have an effect because the current limiting effect of the op-amp output stages will dominate. A value of 82 ohms is the minimum recommended value; 1k gives slightly less brilliance, and 1k8 gives about half brightness. It is possible to have all the resistors the same, in which case any resistors of 82-220 Ohms may be used, and the op-amps will define the intensity possible.

+20-22 VOLTS

330μ

0 V

1N4002   C.T.   1N4002

15 V   15 V

IC1 7815   in   out   ref.

SUPPLY INPUT 17-30 VOLTS

R2 2k7

R1 10k

FROM SPKR POSITIVE

13   IC2a   14   12

D1 1N914 1N4148

R3 4k7

R4 15k

R5 1k2

10   IC2b   8   9

1.05-1.15

R6 1k8

LED1

R7 22k

3   IC2c   1   2

R8 5k6

2.9-3.2

R9 1k

LED 2

R10 10k

5   IC2d   7   6   4   11

R11 10k

7.1-7.9

C1 4μ7 16 V TANT.

R12 82R

LED3

0V   SPKR COMMON

MULTIMETER

AMPLIFIER SUPPLY RAIL
OR SUITABLE POWER SUPPLY

+
0 V

INPUT

50K/A
POT.

ETI-272

0 V
SUPPLY
+

3 2 1

SUPPLY
INPUT
(17-30 V)

0 V

C1 4µ7

IC1
7815

R4 15k R10 10k R11 10k
R6 1k8 R12 82R
R5 1k2 IC2 R7 22k
R3 4k7 324 R8 5k6
D1 R2 R1 R9 1k
2k7 10k

k LED1
a
k LED2
a
k LED3
a

REAR OF
CHASSIS

BLACK RED
SPEAKER TERMINALS

Power up

There is no calibration required, but you may wish to test the circuit to convince yourself that it is telling the truth. Simply take the input wire for each board and, before connecting it to the speaker terminal, connect it to a variable power supply or a pot of about 50k whose end connections are at ground and amplifier rail, such that a crude source of voltage in the appropriate range is obtained, as shown in Figure 1. Connect a voltmeter to the same connection, and observe what the meter reads at each point where a LED comes on. These points will be about 4, 11 and 28 volts respectively if you are using the resistor values, given or the calculated Vpeaks if you have your own values substituted.
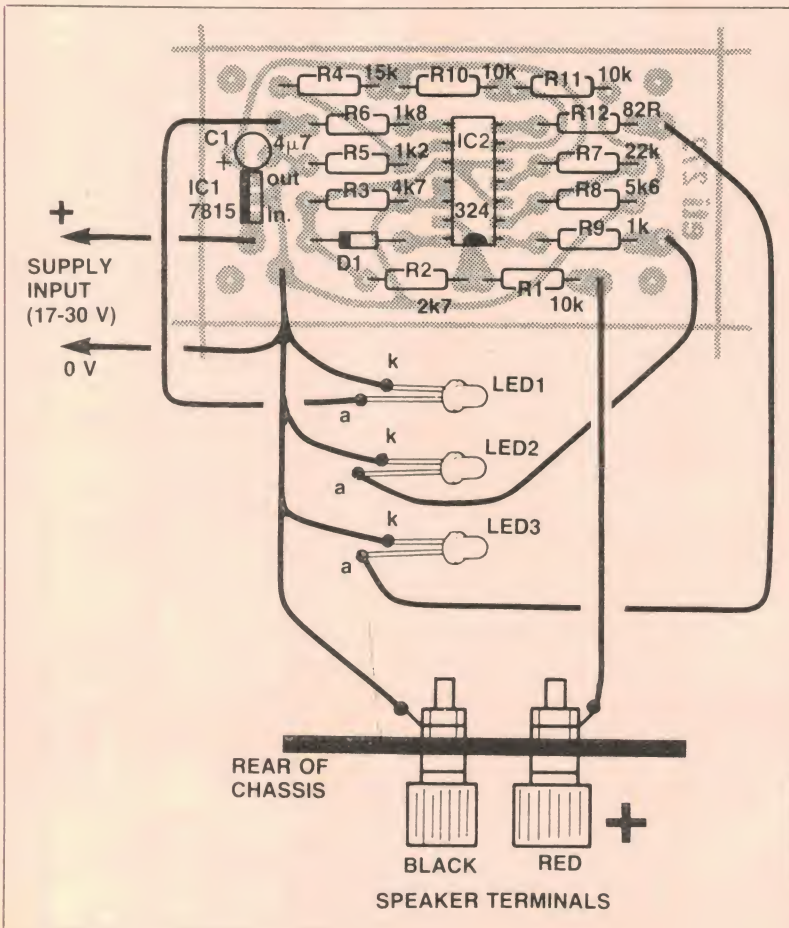
Table 1. Alternate resistor values for LEDs 1, 2 and 3 to light at different power levels.

Power level	LED1		LED2		LED3	
	R4	R5	R7	R8	R10	R11
¼W	15k	560R	—	—	—	—
½W	22k	1k5	—	—	—	—
2.5W	12k	1k5	12k	1k5	—	—
4W	—	—	18k	1k5	—	—
10W	—	—	27k	8k2	27k	8k2
15W	—	—	1k	3k9	10k	3k9
20W	—	—	10k	4k7	10k	4k7
75W	—	—	—	—	10k	15k
100W	—	—	—	—	12k	27k

eti 272