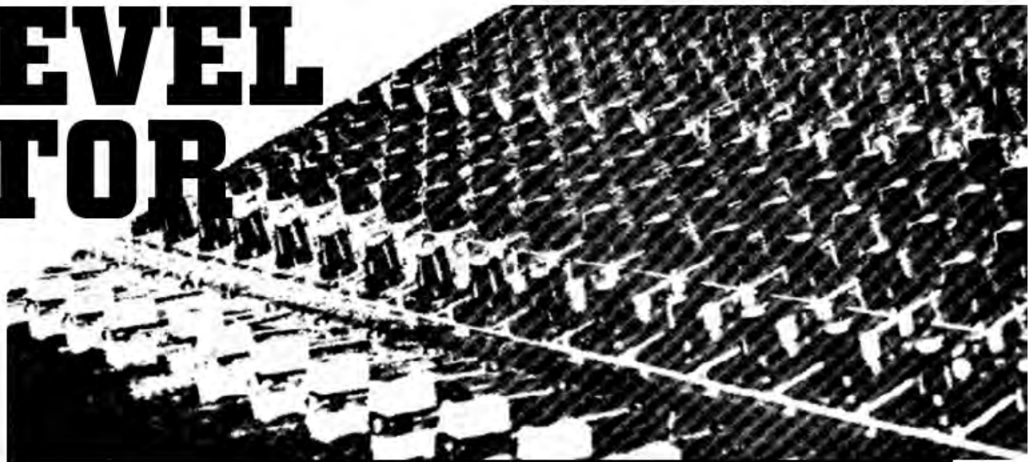
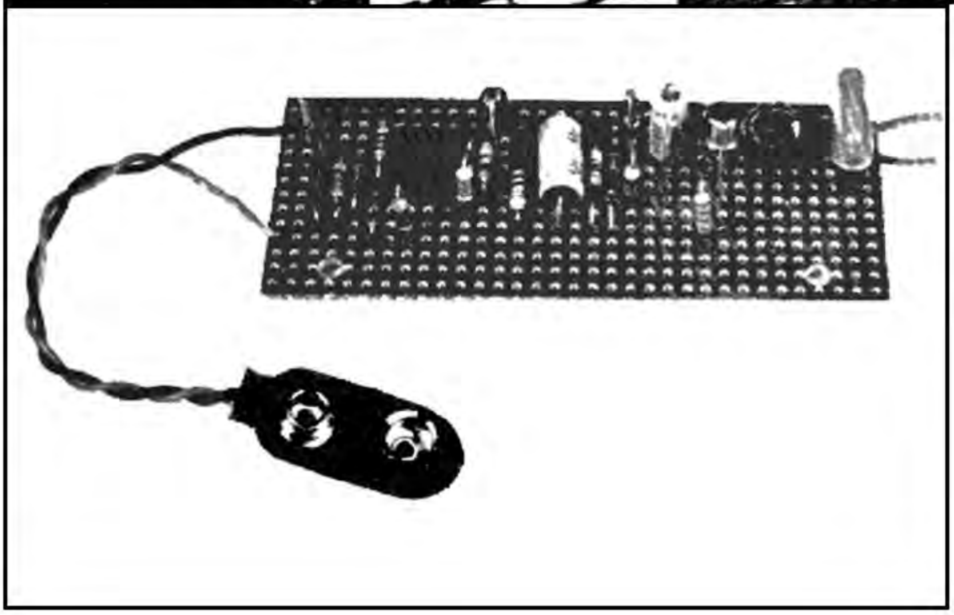
PEAK LEVEL INDICATOR

by Robert Penfold



* **Instantaneous detection of signal overload.**



The shortcomings of average reading VU meters are well known, and the most important of these is their inability to respond properly to signals having a high peak but low average level, so that a low reading is obtained and overloading often occurs in consequence. In order to avoid this it is common for VU meters of the average reading type to be backed-up by a peak level indicator, and this is usually in the form of a LED indicator which flashes on if the peak signal level exceeds some predetermined level.

This simple peak level indicator circuit can be used in conjunction with an average reading VU meter which does not already have the back-up of a peak reading device of some kind, or it could be used in situations where the cost of a VU meter is not justified. It has a multicolour LED indicator which is green for levels below 0 dB, yellow for levels between 0 dB and +6 dB, and red for levels over +6 dB. The circuit has fast attack and slow decay times, like professional peak reading meters.

The Circuit

Figure 1 shows the complete circuit diagram of the Peak Level Indicator, and the unit breaks down into three main sections; a preamplifier, a smoothing and rectifier circuit, and the display driver circuit.

The display driver circuit is based on IC1 and is very similar to part of the CMOS Logic Probe circuit which is described elsewhere in this issue. It will not, therefore, be described in detail here. The two circuits differ only in that this one requires stabilised reference voltages so that variations in the supply voltage do not affect the calibration of the unit. R5 and D3 are therefore used to stabilise the voltage fed to the potential divider chain (R6 to R8) which provides the two reference voltages. R6 is merely included to reduce the

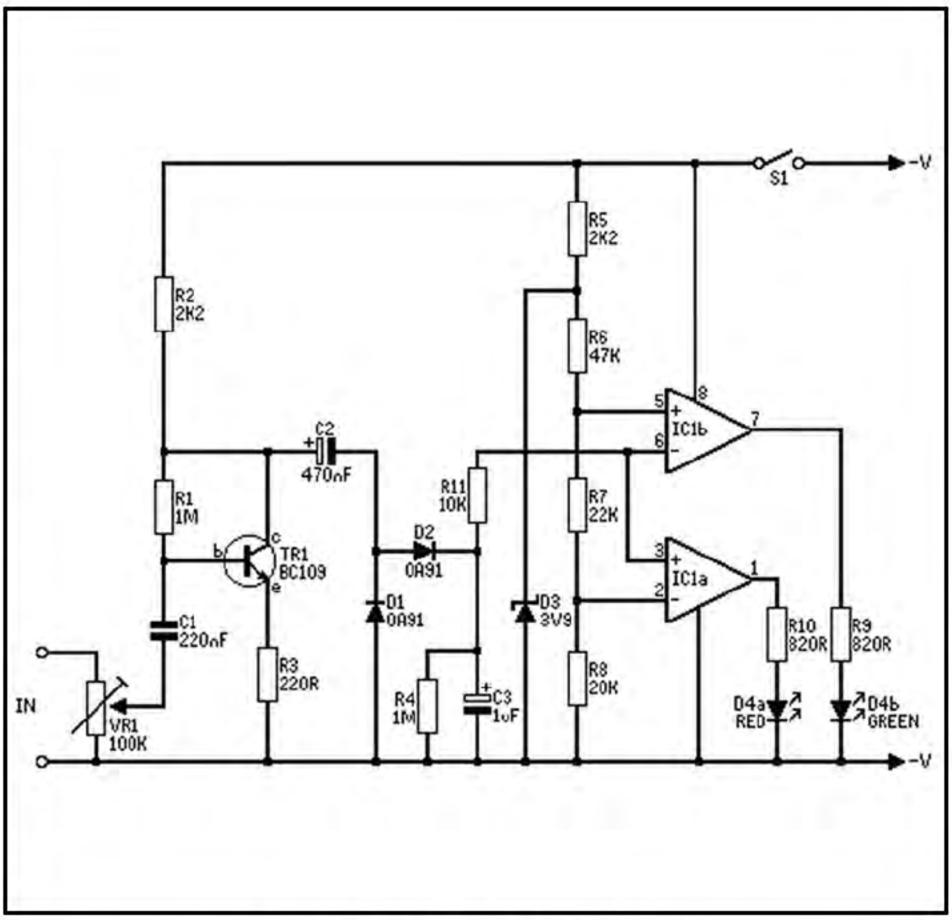


Figure 1. Circuit of the Peak Level Indicator.

reference voltages and thus increase the sensitivity of the circuit.

The input signal could be applied direct to the input of the driver circuit, but this would give low sensitivity, and the rapidly fluctuating input level would give unclear results from the LED indicator as it rapidly switched through its various colours. TR1 is therefore used as a common emitter amplifier having a voltage gain of about ten times (20 dB) to boost the sensitivity of the circuit. VR1 is a preset input attenuator which is used to set the sensitivity of the unit at the correct level. At maximum sensitivity only about 100 mV RMS is needed at the input to drive D4 to the red state, and this should be more than sufficient for any normal application of the unit. The input impedance of the unit is quite high at about 50 to 100 kilohms (depending on the setting of VR1)and it should not have any detrimental effect on the main equipment. Due to the use of a substantial amount of negative feedback over TR1 it does not require a stabilised supply as its voltage gain is largely unaffected by variations in the supply voltage.

C2 couples the output from TR1 to a conventional rectifier and smoothing circuit which consists of Dl, D2, R4 and C3. This circuit has a fast attack time so that the circuit responds properly to transients, but a slow decay time so that the display reverts to green slowly and unambiguous results are obtained. The rectifier circuit introduces a degree of non-linearity between the input signal level and the DC voltage fed to the display driver, but the two reference voltages in the display driver circuit compensate for this and ensure good accuracy.

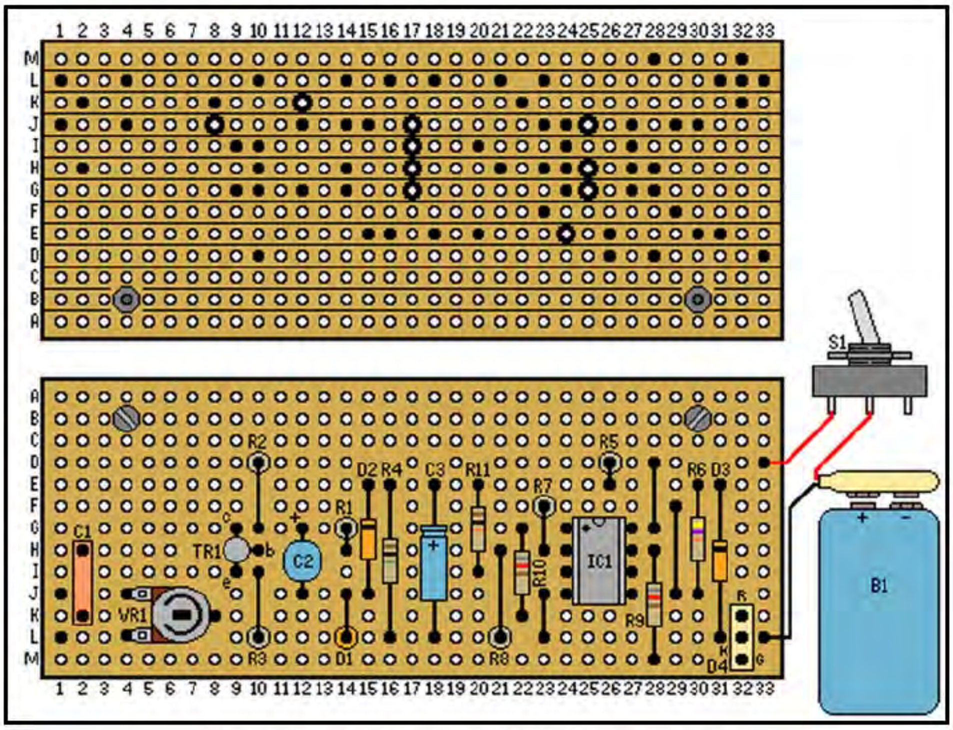


Figure 2. Veroboard layout for the Peak Level Indicator.

Construction

The Veroboard layout for the Peak Level Indicator is shown in Figure 2 and requires a board having 33 holes by 13 strips. IC1 is a MOS device and the normal MOS handling precautions should be taken when dealing with this device. Note also that Dl and D2 are germanium devices which are more susceptible to damage by heat than silicon types. Take care not to overheat these two components when soldering them into place.

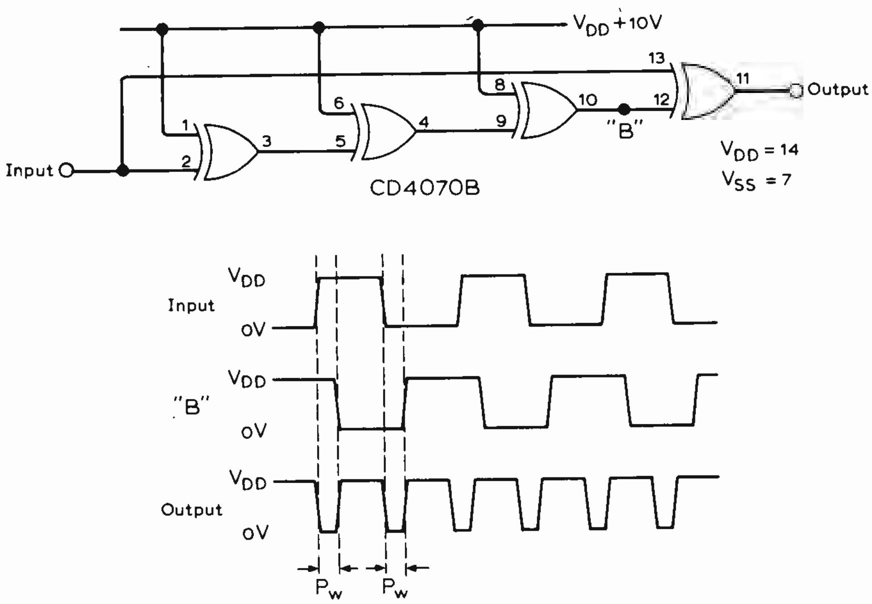
The unit can either be built as a self contained device with its own on/off switch and battery supply, or it might be possible to fit it into the main piece of equipment (although this should only be tried by those with sufficient experience to tackle the job confidently). If the indicator is built as a self contained unit the input leads should be taken to a two way audio connector mounted on the front panel. The input signal is then coupled to this socket via a suitable screened lead. The unit can be powered by a PP3 size battery, but as the current consumption is about 10 to 20 mA it would be better to use a larger type such as a PP7 or PP9 if the unit is to receive a great deal of use as this would give lower running costs.

If the unit is built into the main item of equipment it will probably be possible to power it from the supply of this equipment. A supply potential of around 9 to 12 volts is required. The point from which the input signal is obtained will obviously depend on the precise nature of the equipment with which the indicator is used, but if it is used with equipment having a VU meter it will probably be possible to obtain a suitable signal from the meter's terminals.

Calibrate the unit by first adjusting VR1 fully clockwise, and then applying a steady input signal to the main equipment and adjusting the controls to give a 0 dB signal level. VR1 is then adjusted just far enough in an anticlockwise direction to cause D4 to switch from green to yellow.

PARTS LIST FOR THE PEAK LEVEL INDICATOR

Resistors - all ¼ watt 5% except where specified			
R1, R4	1M	Brown Black Green	(2 off)
R2, R5	2K2	Red Red Red	(2 off)
R3	220R	Red Red Brown	
R6	47K	Yellow Violet Orange	
R7	22K	Red Red Orange	
R8	20K ½ watt 5%	Red Black Orange	
R9, R10	820R	Grey Red Brown	(2 off)
R11	10K	Brown Black Orange	
VR1	100K 0.1W Horizontal preset		
Capacitors			
C1	220nF Polyester		
C2	470nF 50V PC Electrolytic		
C3	1µF 63V Electrolytic		
Semiconductors			
D1, D2	OA91		
D3	BZY88C3V9		
D4	Multicolour LED		
Miscellaneous			
S1	s.p.s.t. miniature toggle switch		
	Case		
	Veroboard 33 holes x 13 strips		
B1	PP3 battery and connector		



Change-of-state detector

A conventional change-of-state detector uses the OR'ed outputs of two monostables triggering from opposite polarity edges. This circuit uses only one exclusive-OR gate i.c., and performs frequency doubling or change-of-state detection. The first three gates are connected as buffers and the final gate exclusive-ORs the output of the buffers and the input. An output pulse of width equal to the total propagation delay of the buffers is obtained, in practice about 100ns, from the CD4070B. This pulse may be extended if necessary by the addition of a <5nF capacitor from point B to ground.

If the line shown tied to V_{DD} is connected to V_{SS} instead, the output polarity is inverted.

S. Roberts,
Sheffield.

Audio overload monitor

This circuit uses two of the four comparators in an LM339 package to provide detection of excessive positive or negative signal peaks. Pulse-stretching is used to ensure that a clear indication of short-duration peaks is given. Bidirectional peak measurement is important as positive and negative peaks may vary by up to 8dB.

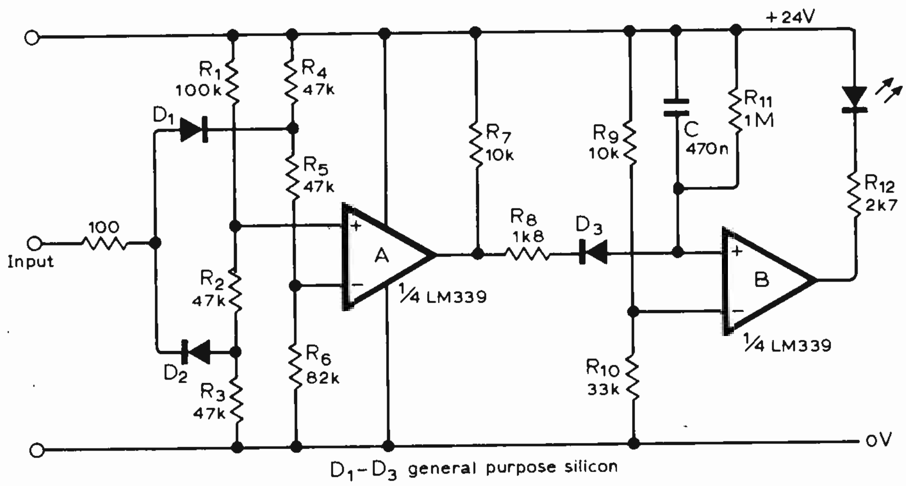
Comparator A detects peaks of either polarity, and the two potential dividers hold the inverting input 400mV below the non-inverting input. If the audio input exceeds the trip point on a positive peak, D_1 conducts which pulls up the inverting input and causes the comparator to change state. Likewise, a suitably large negative peak will make D_2 conduct and pull down the non-inverting input, again causing the comparator output to go low.

When output A goes low, storage capacitor C charges rapidly through D_3 and R_8. When the peak is past, C remains charged and keeps the output of comparator B low so the l.e.d. remains on. The output goes high again after C has discharged through R_{11}, and the l.e.d. is extinguished.

With the values shown, the circuit trips at a peak level equivalent to a 5V r.m.s. sine wave. This is 3dB below the maximum voltage swing to be expected from an amplifying stage operating from a 24V rail. Note that the circuit should not be driven from a high impedance point because the diodes may cause distortion.

A stereo version may be conventiently made using a single LM339 package.

D. Self,
London E.17.

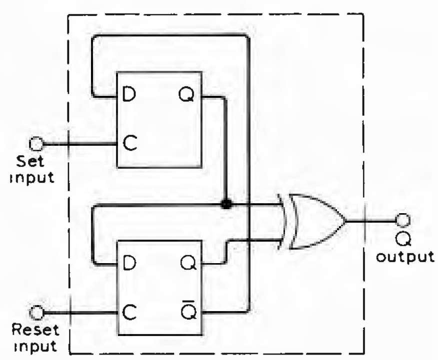


SR flip-flop

Using a c.m.o.s. dual D-type flip-flop and one exclusive-OR gate an SR flip-flop may be made which is triggered by a positive edge on either input, irrespective of the level of the other input.

A positive edge on the set input will force the two flip-flops into opposite states and hence one input to the exclusive-OR will be a 1 and the Q output will be a 1. A positive edge on the reset input will force both flip-flops to the same state, the two exclusive-OR inputs will be equal and the Q output will be a 0.

K. Dillon,
Epsom,
Surrey.



Ideas for experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.
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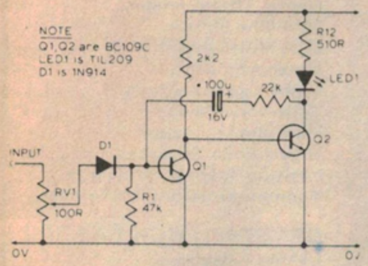
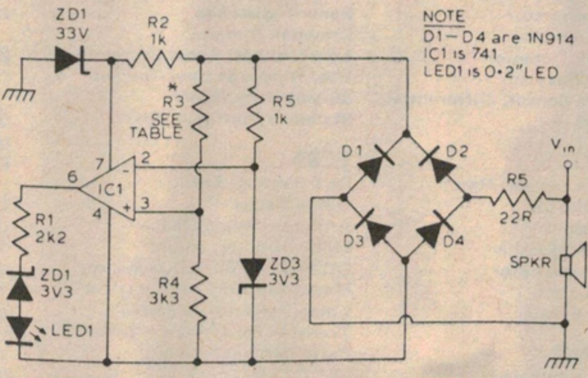


Peak Level Indicator

The diagram shows a simple monstable multivibrator with a LED which is normally lit, but will be briefly extinguished if the input exceeds a preset (by RV1) level. A possible application is to monitor the output voltage across a loudspeaker, when the LED will flicker with large signals.



V	5	10	15	20	25	30	35
R3 kΩ	5·6k	9·1k	12k	15k	16k	18k	22k

Speaker Power Indicator

This circuit will indicate the peak level of an input signal applied to a speaker. It is primarily intended as a fail safe device when connected to an amplifier of higher power rating than the speaker.

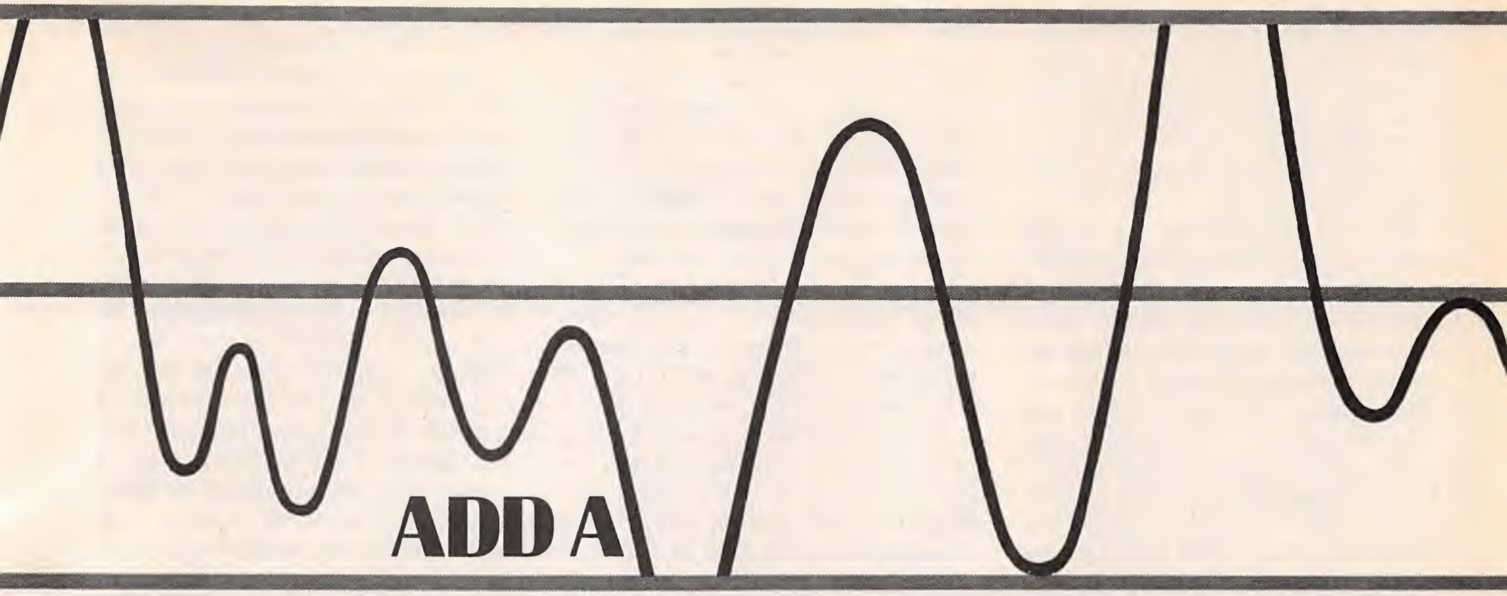
The circuit is unique in that no separate DC power supply is required since the circuitry operates from the input voltage to the speaker.

R5 isolates the amplifier's output stage from possible fault conditions in the circuit. D1 to D4 full wave rectify the input signal and the resulting DC is used to supply the op amp.

The 741 is used as a comparator a reference voltage being obtained from across ZD3 and fed into the inverting input of the op-amp. The non inverting input samples the rectified input signal. When a peak is fed into the circuit the IC's output goes high and the led flashes. ZD1 prevents the LED turning on when the output of IC1 is low due to the output being unable to go less than 1.5V above earth under these circumstances. ZD2 defines the upper limit of the op amp's supply voltage in the presence of large transients whilst R2 is the current limit resistor. It should be obvious that the level at which the led lights is dependent upon the value of R3. The accompanying table shows the value required for the component for different input powers across an 8 ohm load. If different load values are to be used for the speaker the value of R3 can be determined from the equation,

$$R3 = 1.4\sqrt{PR} - 3.3\ k\Omega$$

P = Pout
R = load in Ω



ADD A CLIPPING INDICATOR TO YOUR AUDIO AMPLIFIER

To protect speakers, this simple circuit senses power supply voltages and flashes a warning LED just before the onset of clipping

BY NORMAN PARRON

THE CONSEQUENCES of overdriving an audio power amplifier can range from the unpleasant (ragged, distorted sound) to the catastrophic (burnt, black remains of tweeters and supertweeters). It's obvious, therefore, that the audiophile will want to avoid this condition. The project presented here, an Amplifier Clipping Indicator, will help him do just that. It continually senses both the audio output of the amplifier and the power supply voltages, and flashes a warning LED if the output signal voltage approaches either power supply rail. The user can then reduce the drive level so that the LED stops flashing.

Readily available, inexpensive components comprise the Amplifier Clipping Indicator. Many of them will be found in an experimenter's "junk box." A stereo version can be built in just a few hours, making the Amplifier Clipping Indicator an enjoyable weekend project. The modest amount of power the circuit requires can be tapped from the power amplifier's supply or furnished by a small supply built especially for this purpose.

What Is Clipping? When an audio amplifier is overdriven, it "clips" the input signal. The process is shown graphically in Fig. 1. A power amplifier is driven by a sinusoidal input signal having maximum positive and negative amplitudes of $+V_{IN}$ and $-V_{IN}$, respectively (Fig. 1A). The amplifier generates an output signal that is (ideally) an exact replica of the input except for its increased amplitude.

Because the amplifier must reproduce ac waveforms, it employs a bipolar dc power supply. This means that the most positive voltage it can produce at the output terminals is $+V_{CC}$, and the most negative voltage is $-V_{CC}$. If the amplifier's gain control is adjusted so that the output signal approaches the limits imposed by the power supply, a waveform like that shown in Fig. 1B is generated. It can be seen that the maximum positive and negative swings of the output voltage, $+V_{OUT}$ and $-V_{OUT}$, are somewhat less than the absolute limits of $+V_{CC}$ and $-V_{CC}$.

Adjusting the control for more gain causes the amplifier to attempt to exceed the constraints of the power supply. The result is a clipped waveform like that shown in Fig. 1C. Spectral analysis of such a waveform indicates the presence of high-order harmonic distortion products during the interval that clipping takes place. If the output signal is clipped less than 1% of the time, the effect is usually inaudible. As the duration of clipping approaches 10%, the usual consequence is audible, "raspy" distortion. A severely clipped signal (more than 10% of the time) contains a considerable amount of high-frequency energy. This energy poses a significant threat to midrange and high-frequency drivers because it is directed to them by the crossover network and they are usually capable of dissipating far less power than bass drivers.

Although the example that has been discussed used sinusoidal signals, an audio amplifier usually processes musical signals that are much more complex. It is characteristic of most recorded music that the average signal level is low. However, musical program material does contain a significant number of short-lived, high-level transients. An amplifier might be called upon to deliver one watt of output power on an average basis, but accurate reproduction of a bass percussion transient can require fifty to one-hundred times that power level for a brief instant.

All is well if the amplifier has enough voltage and current reserves to pass the transient unclipped. However, if the amplifier cannot do so, the dynamic range of the recording will be compressed and audible distortion products introduced. This, coupled with the fact that perceived loudness is a function of average (as opposed to peak) power, explains the trend toward power output capabilities that were unheard of in audio amplifiers a relatively short time ago. So-called "super-power" amplifiers allow the audiophile to listen to program material at realistic levels without clipping high-level transients, even if inefficient speakers are used.

About the Circuit. The Amplifier Clipping Indicator is shown schematically in Fig. 2. Each channel of amplification in a sound system will require a separate indicator circuit. The most common application for the project is in a stereo system, so component numbers for two channels are shown. Those for the right channel are given in parentheses. The discussion that follows pertains to only one channel, designated the left channel of a stereo pair. Everything that will be said, however, applies equally to as many channels as are needed because the indicator circuit is identical for each.

Output signals from the audio amplifier are applied to an 11:1 voltage attenuator (*R1R3*). Similarly, the positive and negative supply voltages, $+V_{CC}$ and $-V_{CC}$, are applied to attenuators *R5R7* and *R9R11*. The voltage dividers associated with the power-supply outputs, however, employ trimmer potentiometers and have variable attenuation factors. Those portions of the input voltages passed by the attenuators are applied to two 741 operational amplifiers (*IC1A* and *IC1B*) employed as voltage comparators.

Assume that the trimmer potentiometers have been adjusted to attenuate the power supply voltages slightly more than the fixed divider attenuates the audio signal. If the amplifier is being driven by an audio signal, but not to the point of clipping, its output voltage will be smaller in magnitude than either the positive or negative supply voltage. This means that the voltage applied to the noninverting input of *IC1A* is never more positive than that applied to the inverting input, and the output of the comparator remains at −12 volts. Similarly, the voltage applied to the inverting input of *IC1B* remains positive with respect to that present at the noninverting input, keeping the output of *IC1B* at −12 volts.

Diodes *D1* and *D3* form an OR gate whose output goes to +12 volts when either of the comparator outputs does. In the absence of clipping, both *D1* and *D3* are reverse-biased, which keeps transistor *Q1* cut off. Monostable multi vibrator *IC3* remains untriggered and its output (pin 3) is at ground potential. This keeps *D7*, which together with *D5* forms a second diode OR gate, in a nonconducting state. The output of the *D1D3* OR gate is applied to the *D5* input of the second gate. Both inputs are low, so *Q3* receives no base drive and the clipping indicator LED (*LED1*) remains dark.

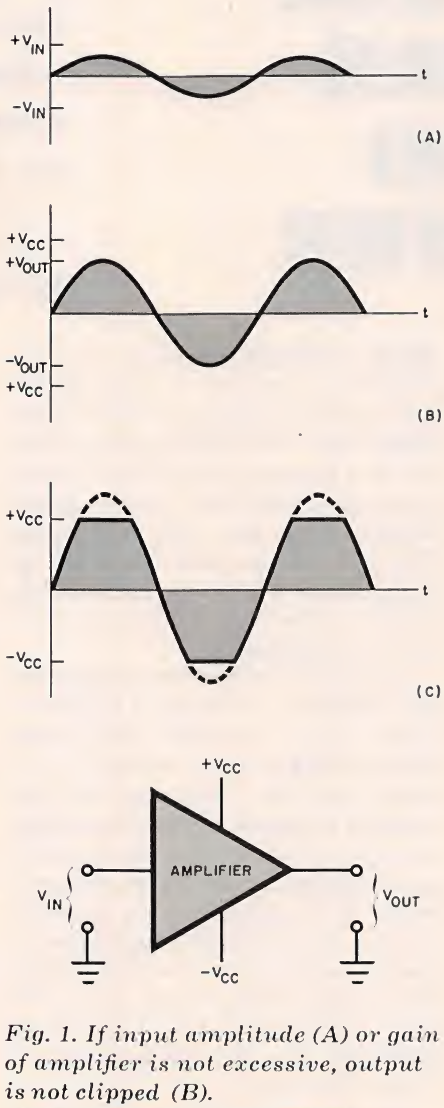


Fig. 1. If input amplitude (A) or gain of amplifier is not excessive, output is not clipped (B). Increasing one or both causes amplifier to clip the output (C).

Now let's assume that the audio amplifier is driven into clipping. The audio output voltage reaches the positive or negative supply voltage (or both) and is clipped like the one shown in Fig. 1C. When the positive portion of the audio waveform applied to the noninverting input of *IC1A* becomes more positive than the voltage at the inverting input, the output of the comparator goes to +12 volts, this forward-biases *D1* and *D5*, and provides base drive for *Q1* and *Q3*. A similar thing happens when the negative portion of the audio waveform is clipped. The voltage applied to the inverting input of *IC1B* becomes more negative than the voltage at the noninverting input, so the output of this comparator switches to a +12-volt level. This forward biases *D3* and *D5*, providing base drive for *Q1* and *Q3*.

When *Q3* is supplied with base current, it turns on and the clipping indicator LED glows. However, the clipping interval can be so short that the eye will not readily detect the brief flash of the LED. That's why *Q1*, *IC3*, and their associated components have been included. Together they function as a pulse-stretching circuit. Here's how.

When the output of either comparator goes high, *Q1* receives base current and its collector drops to ground potential. A negative pulse is passed by *C1* to pin 2 of *IC3*, triggering this monostable multivibrator. The output of the timer IC (pin 3) goes high for an interval determined by the time constant of *R19C5*. For the values given, the width of the output pulse is about 0.25 second. This output pulse is OR'ed with the output of gate *D1D3* and applied to resistor *R21*. Transistor *Q3* receives base drive and sinks current for *LED1*, causing the clipping indicator LED to glow.

The pulse-stretcher turns the LED on for one quarter of a second even if the clipping interval is much shorter. A subsequent trigger pulse received while the monostable is timing will not retrigger it. However, one received immediately after a timing cycle will cause the process to be repeated. If the clipping interval is longer than the width of the output pulse (which can be extended to any desired interval by increasing the value of *R19* or *C5* or both), the OR'ing action of *D5* and *D7* will keep *Q3* in a conducting state. Therefore, the clipping indicator LED will continue to glow even after the output of the monostable has returned to its ground state. It will glow until the audio amplifier recovers from the clipping condition.

The project requires a bipolar power supply of ±12 volts dc. These operating voltages can usually be tapped from the audio amplifier's power supply. Zener diodes and series current-limiting resistors can be used to drop the amplifier's $+V_{CC}$ and $-V_{CC}$ supply voltages to the desired values. Alternatively, a small line-powered supply can be built into the project's enclosure. Current demand is relatively modest—a few milliamperes for the −12-volt supply and about 50 mA from the positive rail.

Because dynamic voltage comparison is the method employed to sense clipping, this project enjoys a significant advantage over such power-monitoring devices as peak-reading meters and strings of LEDs. A peak-reading meter only indicates that the audio output has reached a given level. It will not necessarily indicate that clipping is taking place. For the sake of illustration, let's consider what happens to an amplifier with an unregulated power supply when it is driven by an audio signal with many high-level transients.

Suppose that our amplifier can deliver 75 watts per channel of continuous power to 8-ohm loads and has an IHF dynamic headroom of 2.04 dB. This means that it can deliver 120 watts of output power into 8 ohms for brief intervals. Consequently, the power supply voltages under full load are +34.6 volts and −34.6 volts. When the demand on the power supply is light, the available voltages are +43.8 and −43.8 volts.

If the supply's filter capacitors have charged up to these higher voltages and a short-lived, high-level transient arrives at the amplifier's audio input, the output stage can momentarily generate an 87.6-volt peak-to-peak waveform without clipping it. However, driving the amplifier this hard causes the voltages across the filter capacitors to decrease. If the amplifier is called upon to reproduce a second high-level transient before the filter capacitors have had an opportunity to recharge sufficiently, clipping will result.

It can thus be seen that a peak-reading audio power meter will not *necessarily* indicate that the amplifier is clipping. In our example, the lowest possible power supply voltages are +34.6 and −34.6 volts, so we can safely say that any audio output signal with a peak power of up to 75 watts as indicated on the peak-reading monitor will not be clipped. Above that power level, however, the meter reading alone will not tell us whether clipping is taking place. By contrast, a flash of the indicator LED in this project warns of the onset of clipping, a warning which takes into account the dynamics of the amplifier's power supply.

Construction. Either printed circuit or perforated board can be used in the assembly of the Amplifier Clipping Indicator. In any event, the use of IC sockets is recommended. Be sure to use the minimum amount of heat and solder consistent with the formation of good solder joints. Also, observe the polarities and pin basings of semiconductors and electrolytic capacitors.

After the project's circuit board has been completed, connect it to *BTS1* and the indicator LED(s) with suitable lengths of hookup wire. Then secure the board to the project enclosure with standoffs and machine hardware. Mount *BTS1* on the rear panel of the enclosure

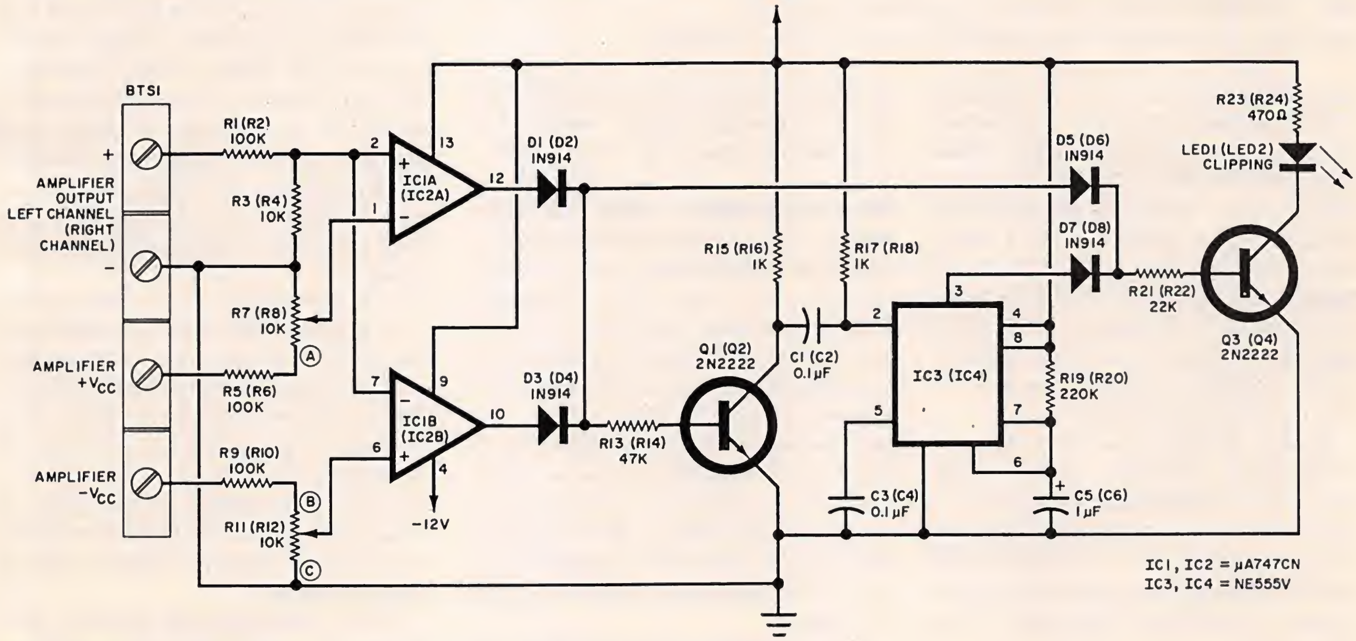


Fig. 2. Schematic of the clipping indicator circuit for one channel.

PARTS LIST

BTS1—Four-position (Six-position) barrier terminal strip
C1 through C4—0.1-µF disc ceramic
C5,C6—1-µF tantalum
D1 through D8—1N914
IC1, IC2—µA747CN dual operational amplifier
IC3,IC4—NE555V timer
LED1,LED2—Light emitting diode
Q1 through Q4—2N2222
The following are ¼-watt, 5% tolerance carbon composition fixed resistors unless otherwise specified.
R1,R2,R5,R6,R9,R10—100,000 ohms
R3,R4—10,000 ohms
R7,R8,R11,R12—10,000-ohm, linear-taper trimmer potentiometer
R13,R14—47,000 ohms
R15,R16,R17,R18—1000 ohms
R19,R20—220,000 ohms
R21,R22—22,000 ohms
R23,R24—470-ohms, ½-watt, 10% tolerance
Misc.—Suitable enclosure, printed circuit or perforated board, bipolar 12-volt power supply, IC sockets or Molex Soldercons, LED mounting collars, machine hardware, hookup wire, solder, etc.

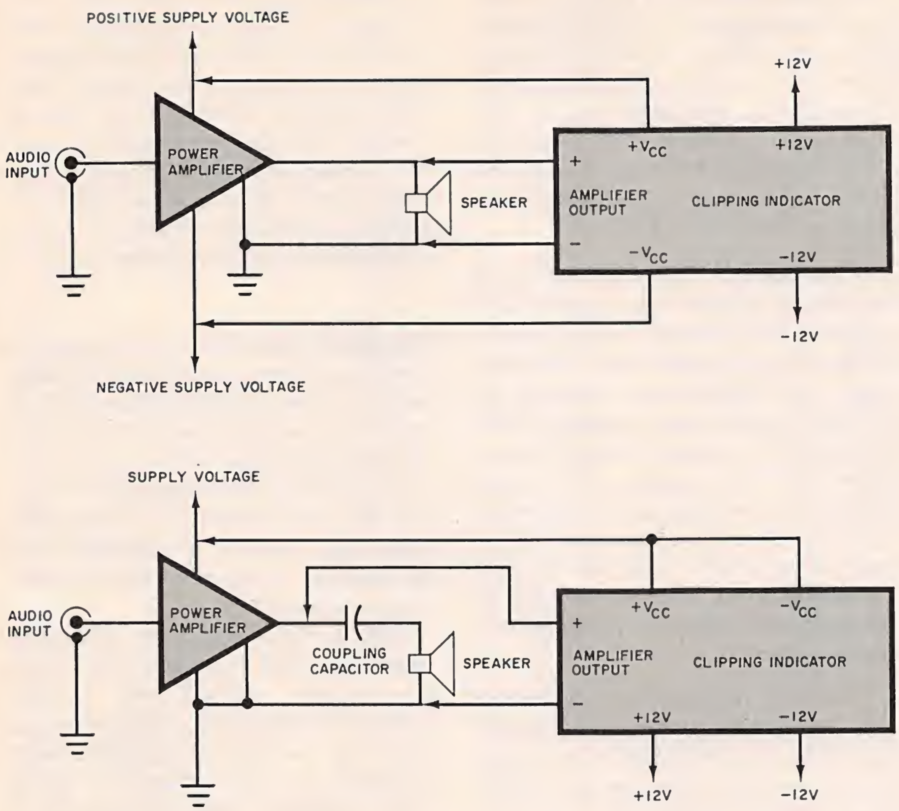


Fig. 3. Diagram showing details of interconnection for amplifiers with bipolar (A) and single-ended (B) power supplies

with machine hardware and the indicator LED(s) on the front panel with rubber grommets or mounting collars made especially for this purpose. As mentioned earlier, operating power for the project can be obtained from a small supply included inside the enclosure or tapped from the amplifier itself if a bipolar dc supply is employed. If the latter approach is taken, the required zener diodes and series resistors will easily fit inside the project enclosure.

Another possible approach, if there is room in the amplifier chassis, is to mount the entire project inside the amplifier and locate the indicator LEDs on the front panel. If this is done, *BTS1* can be eliminated and the connections to the speaker outputs and $+V_{CC}$ and $-V_{CC}$ hard-wired.

Note that the circuit as shown will function properly with audio amplifiers having supply voltages of up to ±60 volts (or +80 or −80 volts in the case of an amplifier with a single-ended supply). That bipolar voltage corresponds to a clipping power of 225 watts into 8 ohms. The project is therefore useable with the vast majority of audio amplifiers commercially available. If you have an amplifier employing greater supply voltages, the circuit can be suitably modified simply by increasing the attenuation factors of the input voltage dividers (increasing the values of *R1*, *R5*, and *R9*).

Interconnection and Adjustment. If your audio amplifier employs a bipolar dc power supply (most do), connect the $+V_{CC}$ and $-V_{CC}$ terminals of *BTS1* to the power supply outputs inside the amplifier. (Note that making these connections will, in most cases void the warranty on your amplifier.) Also, connect the AMPLIFIER OUTPUT terminals of *BTS1* to the amplifier's speaker output terminals in agreement with the polarities indicated in Fig. 2. These connections can be made with standard "zip-cord" or speaker wire. Refer to Fig. 3A for details.

Slightly different connections should be made if your audio amplifier employs a single-ended power supply and a coupling capacitor or transformer between the final amplifying devices and the speaker output terminals. The required connections are as follows: connect the $+V_{CC}$ *and* $-V_{CC}$ terminals of *BTS1* to the "hot" side of the power supply output; and connect the "hot" AMPLIFIER OUTPUT terminal of *BTS1* to the "hot" side of the amplifier output *before* the output coupling (dc blocking) capacitor or transformer. Refer to Fig. 3B.

The circuit's trimmer potentiometers can now be adjusted. Referring to Fig. 2, note the points near *R7* and *R11* designated *A*, *B*, and *C*. If your audio amplifier has a bipolar power supply, adjust the wiper of *R7* so that it is at position *A* and the wiper of *R11* so that it is at position *B*. If your amplifier's power supply is single-ended, adjust the wiper of *R7* so that it is at position *A* and the wiper of *R11* so that it is at position *C*.

Two pieces of test equipment are needed to adjust the trimmer potentiometers properly. The first is a sine-wave generator whose output is of sufficient amplitude to drive the audio amplifier into clipping. (One volt peak-to-peak of drive signal is usually more than adequate.) The second item can be either an oscilloscope or a multimeter, but the former is preferred. We will first describe the procedure to be followed if an oscilloscope is available and then that to be employed if one is not.

Connect a patch cord between the output of the signal generator and the input of the audio amplifier. Then connect the probe running from the oscilloscope's vertical amplifier input to the audio output of the power amplifier. Apply power to the project, signal generator and audio amplifier. Then adjust the amplitude of the generator's output, the gain of the audio amplifier, and the various oscilloscope controls for a stable, sinusoidal trace. The output of the audio amplifier should not be connected to a speaker.

Increase either the gain of the amplifier or the amplitude of the generator output until the oscilloscope trace just begins to reveal clipping of the waveform. Then decrease either the amplifier gain or signal output so that the amplitude of the waveform decreases a few volts below each clipping limit. (This provides a small safety margin so that the indicator LED will start to flash just before clipping actually begins.)

Without disturbing the amplifier, generator, or oscilloscope control settings, adjust trimmer *R7* until the LED starts to flash on positive signal peaks. Make a pencil mark on the circuit board denoting the correct position of the wiper and then return the control to its original setting. Next, adjust *R11* so that the indicator LED starts to flash on negative signal peaks. Once the correct setting of *R11* has been found, don't disturb it. Return to *R7* and adjust its wiper so that it corresponds to the position marked on the circuit board. Decrease the amplitude of the generator output or the gain of the amplifier, noting that the indicator LED will be extinguished. If you have built more than one Amplifier Clipping Indicator, say, for use with a stereo or four-channel audio amplifier, repeat the procedure just described for each.

Those who do not have acess to an oscilloscope can use a VTVM, VOM, or similar multimeter to adjust the project. First, the power supply limitations of the amplifier with which the project will be used must be determined. Connect the signal generator to the amplifier as described above and adjust the generator for a 60-Hz output. Connect the amplifier's speaker output to an 8-ohm load (a resistor is best) and apply a moderate amount of drive to the amplifier input. With the power supply loaded, measure its output voltage(s). Increase the gain of the amplifier or the amplitude of the drive signal and note whether the power supply voltages decrease. If they do, measure the *minimum* values.

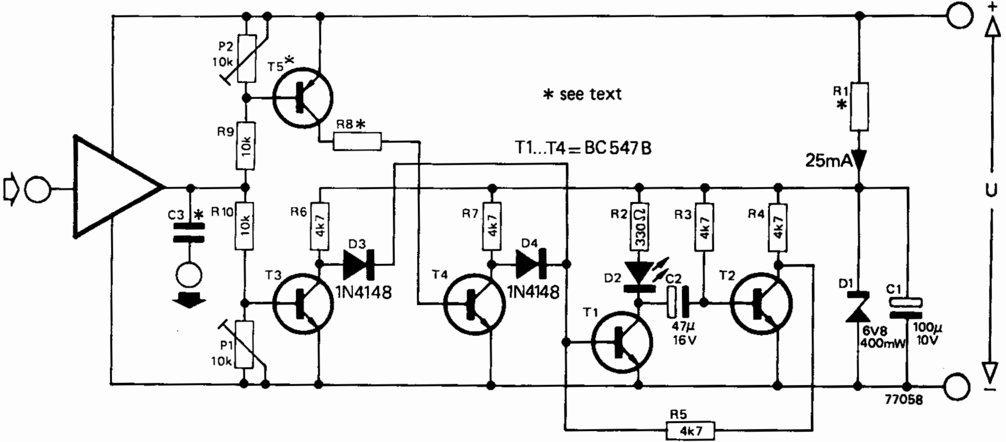
Having performed these measurements, determine the peak-to-peak voltage swing that the output can generate. For example, if the minimum voltages that a bipolar power supply generates under maximum drive conditions are +30 and −30 volts, the continuous peak-to-peak signal that the amplifier can pass at the onset of clipping is 60 volts p-p. Next, calculate the rms output voltage using the equation $V_{rms} = V_{p\text{-}p}/2.828$. For our example, the rms output voltage is 21.2 volts.

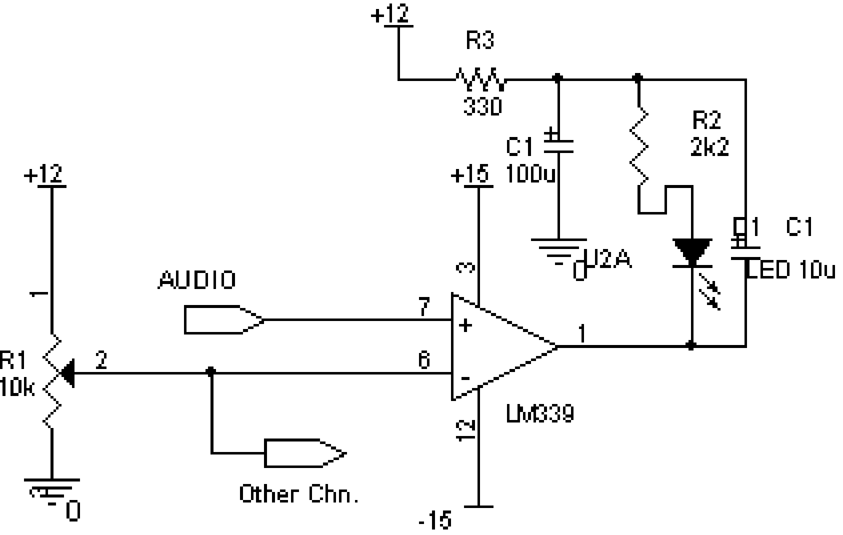
Connect the multimeter probes across the 8-ohm load and adjust the amplifier's gain or the amplitude of the input signal so that the calculated rms voltage is indicated by the meter. Then decrease the gain or the drive signal so that the meter reading is a few volts below the calculated value. (This provides the safety margin previously discussed.) Now adjust the trimmer potentiometers in the same manner described in the procedure employing the oscilloscope. Repeat the procedure for each additional channel of amplification (if any).

Use. The Amplifier Clipping Indicator is now ready for use. With it, you'll be able to adjust drive level and/or amplifier gain so that your amplifier will never go into heavy clipping. Keep in mind that the indicator LED will begin to flash slightly before the the onset of clipping. If the LED starts to blink, back off on the drive level or gain control. Your high-frequency drivers will be glad you did! ◇

84

clipping indicator





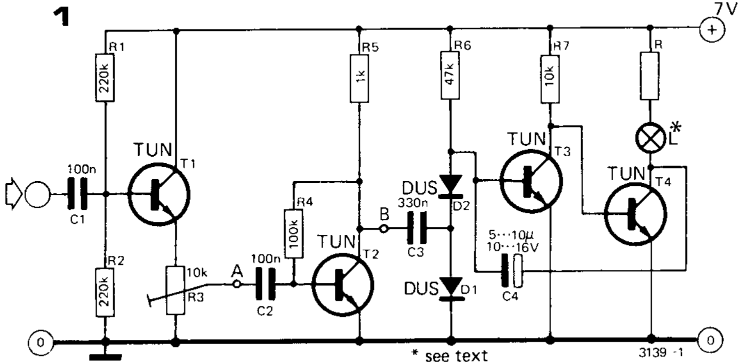
+12
R3
330
C1
100u
R2
2k2
+15
+12
1
U2A
0
3
D1
C1
LED 10u
AUDIO
7
+
1
R1
10k
2
6
-
LM339
12
Other Chn.
0
-15

36

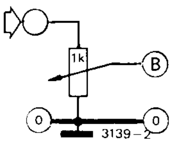
overmodulation indicator

J. Tabel

1



2



During recording on tape, it is necessary to ensure that the signal voltage at some point does not exceed a predetermined level. A similar situation can occur with (pre-)amplifiers and measuring instruments.
In such cases a meter-type indication is not the only possibility – and indeed it is invariably not the best. An overmodulation indicator that lights a lamp is cheaper – and gives a more distinct warning. The accompanying circuit is designed for this purpose.
Transistor T1 is an emitter follower, providing a high input impedance (about 100 kΩ) to minimize the load on the signal source. The trimmer R3 sets the voltage at which the lamp will just light up (overmodulation level).
The circuit around T2 is a x 100 amplifier which enables the threshold to be set as low as 5 mV. When this high sensitivity is not needed, i.e. when the threshold is 0.5 volt or higher, the stage can be omitted. The points A and B are then bridged. If the high input impedance is also unnecessary, as for instance when a loudspeaker-connection is being monitored, it is obviously permissible to omit the input stage also. Figure 2 shows how the input is made to point B in this case.
The circuit following point B is the indicator proper. The current through R6 normally 'bottoms' T3, so that T4 is cut off. Alternating signal voltage at point B however, rectified by the action of D1, D2, C3 and C4, will cause a negative drive to be applied to T3 base. When this AC voltage exceeds about 0.5 volts, T3 will no longer be bottomed, so that T4 will start to conduct. 'Monoflop' action via C4 will now ensure that even short signal peaks are clearly indicated by the lamp.
When selecting the type of lamp, one should note that the maximum available current is about 100 mA. With a supply voltage of 7 V as shown, the lamp should be a 6 ... 7 volt type. If circumstances dictate, a resistor can be inserted in series with the lamp. Given the supply voltage (V_B), the lamp voltage (V_L) and the lamp current (I_L) in amps, the series resistor (R) value required is:

$$R = \frac{V_B - V_L}{I_L}$$

To take an example, suppose that a 6 volt 50 mA (= 0.05 A) lamp is to be used on a 9 volt supply:

$$R = \frac{9 - 6}{0.05} = 60\ \Omega,$$

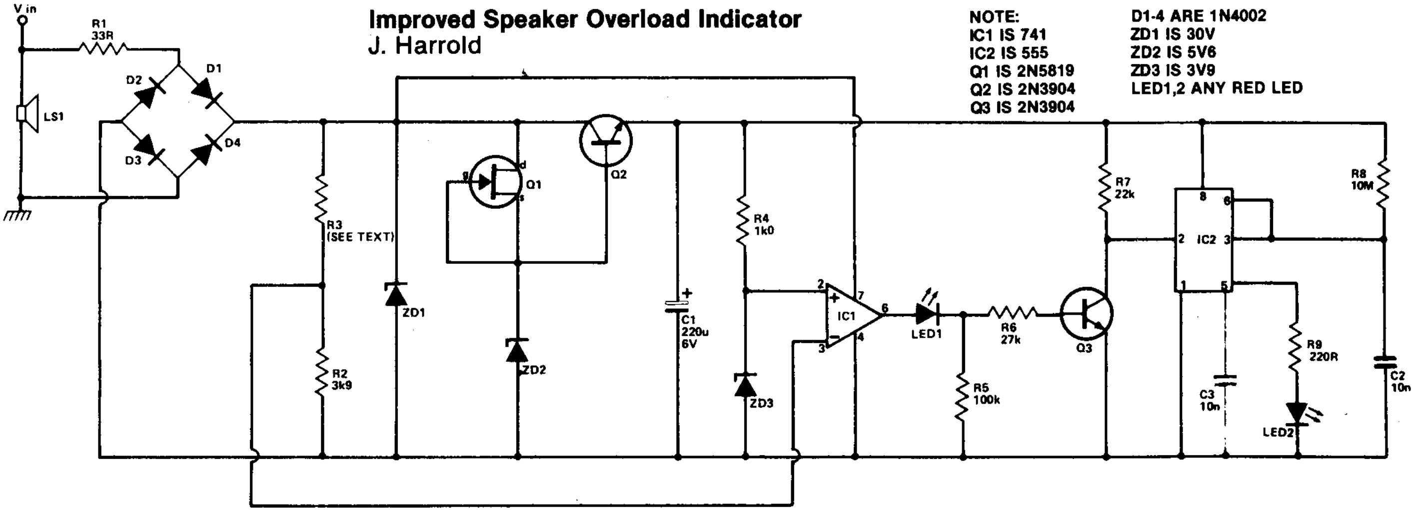
for which the nearest lower standard value of 56 Ω would be taken.

Improved Speaker Overload Indicator

J. Harrold

NOTE:
IC1 IS 741
IC2 IS 555
Q1 IS 2N5819
Q2 IS 2N3904
Q3 IS 2N3904

D1-4 ARE 1N4002
ZD1 IS 30V
ZD2 IS 5V6
ZD3 IS 3V9
LED1,2 ANY RED LED



This circuit is based on a design by J.P. Macaulay. This one offers an improvement in performance, which is low cost and does not introduce an external DC power supply.

The voltage at the speaker output terminals is rectified and then passed to potential divider R2, R3. ZD1 provides 'last ditch' protection for Q1 and IC1 (this method is not suitable if indication of overloads of greater than 50 W is required). Q1 is used as a voltage variable resistor and with ZD2, series pass transistor Q2 and C1, provides a regulated supply. This supply improves the stability of the 3V9 reference potential at the inverting input of IC1 and also provides a stable supply for IC2 and its timing components R8, C2. C1 cannot be placed between 0V and the collector of Q2 as this would have an adverse filtering effect on high frequency signals. When the voltage across R2 is less than 3V9, the output from comparator IC1 is low (about 1V5) and this voltage is dropped across forward biased red LED 1 (or alternatively any three silicon diodes in series). Q3 is off and the trigger (pin 2) of IC2 is high. When the voltage across R2 exceeds 3V9, IC1 output goes high and Q3 is turned on, lowering the voltage at IC2 pin 2, triggering the monostable and lighting LED 2 for a period dependent on R8, C2 (about 100 mS with given values). C2 must be a low leakage type (not ceramic).

the generator output or the gain of the amplifier, noting that the indicator LED will be extinguished. If you have built more than one Amplifier Clipping Indicator, say, for use with a stereo or four-channel audio amplifier, repeat the procedure just described for each.

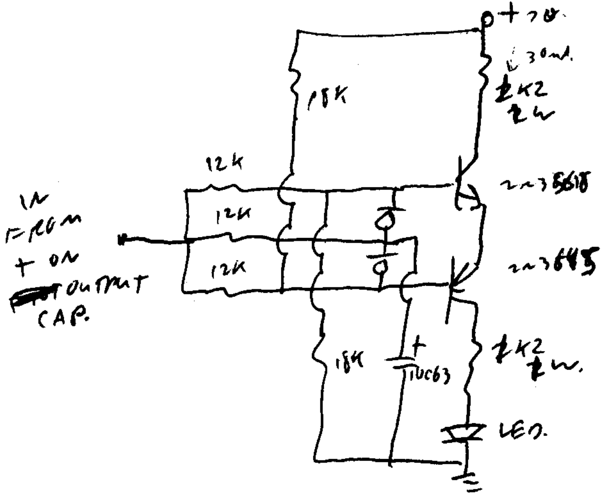
Those who do not have acess to an oscilloscope can use a VTVM, VOM, or similar multimeter to adjust the project. First, the power supply limitations of the amplifier with which the project will be used must be determined. Connect the signal generator to the amplifier as described above and adjust the generator for a 60-Hz output. Connect the amplifier's speaker output to an 8-ohm load (a resistor is best) and apply a moderate amount of drive to the amplifier input. With the power supply loaded, measure its output voltage(s). Increase the gain of the amplifier or the amplitude of the drive signal and note whether the power supply voltages decrease. If they do, measure the *minimum* values.

Having performed these measurements, determine the peak-to-peak voltage swing that the output can generate. For example, if the minimum voltages that a bipolar power supply generates under maximum drive conditions are +30 and −30 volts, the continuous peak-to-peak signal that the amplifier can pass at the onset of clipping is 60 volts p-p. Next, calculate the rms output voltage using the equation $V_{rms} = V_{p\text{-}p}/2.828$. For our example, the rms output voltage is 21.2 volts.

Connect the multimeter probes across the 8-ohm load and adjust the amplifier's gain or the amplitude of the input signal so that the calculated rms voltage is indicated by the meter. Then decrease the gain or the drive signal so that the meter reading is a few volts below the calculated value. (This provides the safety margin previously discussed.) Now adjust the trimmer potentiometers in the same manner described in the procedure employing the oscilloscope. Repeat the procedure for the circuit associated with each additional channel of amplification (if any).

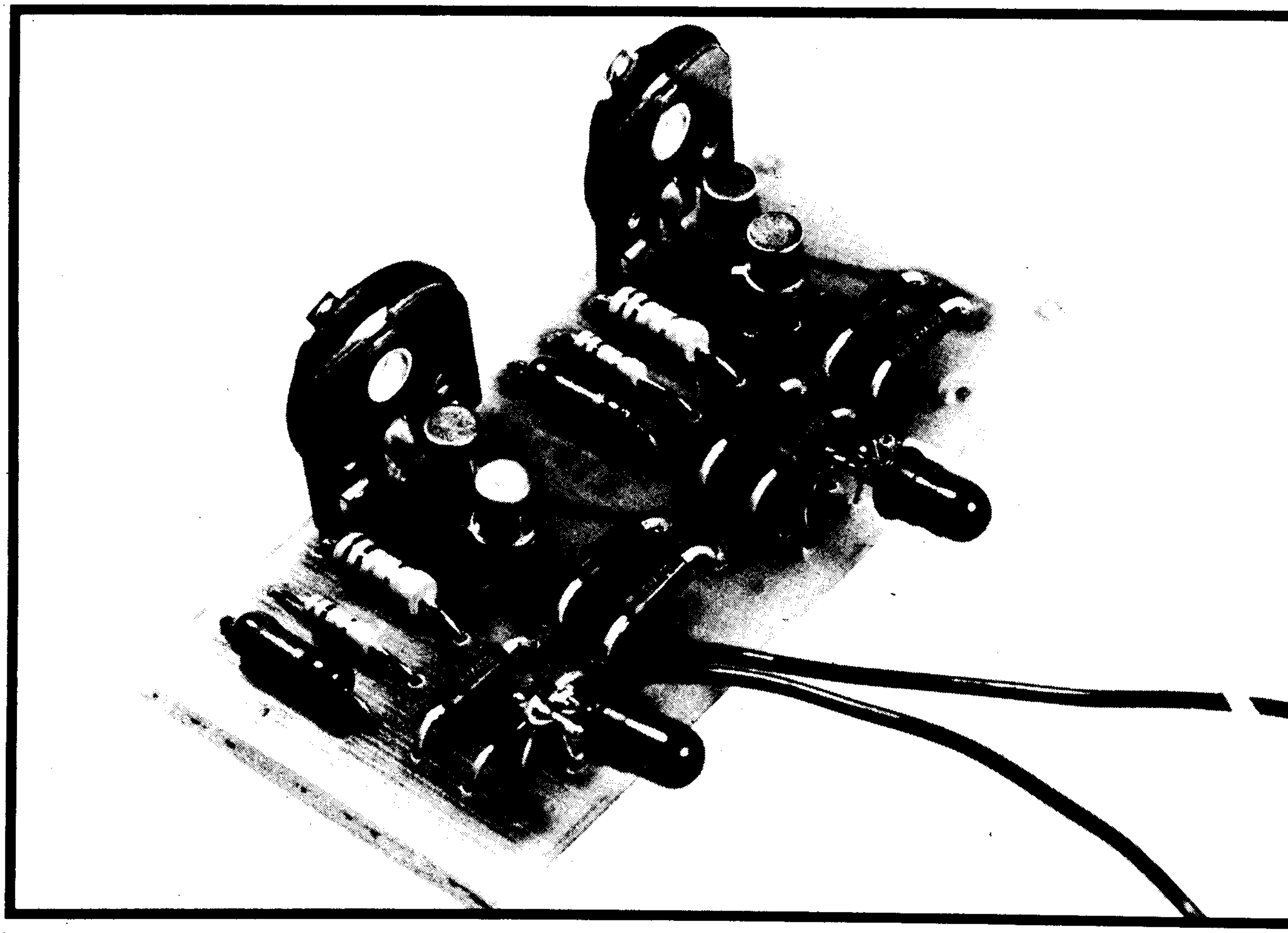
Use. The Amplifier Clipping Indicator is now ready for use. With it, you'll be able to adjust drive level and/or amplifier gain so that your amplifier will never go into heavy clipping. Keep in mind that the indicator LED will begin to flash slightly before the the onset of clipping. If the LED starts to blink, back off on the drive level or gain control. Your high-frequency drivers will be glad you did! ◇

FOR SINGLE SUPPLY AMPS



$R = \frac{70}{.03} = 70 + 33 = 2K2$

CLIP INDICATORS.
Automatically calibrates to amp output.



eti project

THE OVER-LED

Is your power amplifier clipping? This simple monitor lets you know.

TABLE 1

RMS watts per channel	4Ω R1	4Ω R3	8Ω R1	8Ω R3	16Ω R1	16Ω R3
5	68	5.6k	82	8.2k	120	12k
10	82	8.2k	120	10k	180	18k
15	100	10k	150	15k	220	22k
20	120	12k	180	18k	240	24k
25	150	15k	220	22k	270	27k
35	180	18k	240	24k	330	33k
50	220	22k	270	27k	390	39k
75	240	24k	330	33k	470	47k
100	270	27k	390	39k	560	56k

(SPEAKER IMPEDANCE)

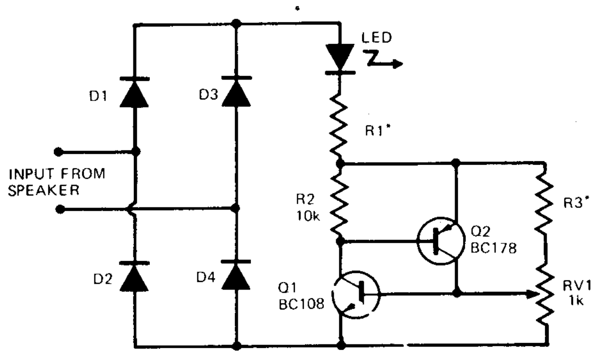
MANY people are aware of distortion when they turn up the volume control on their hi-fi equipment – but are usually unaware of the cause.

Nine times out of ten this distortion is caused by 'clipping'. That is, the amplifier does not have enough reserve power to handle the peak music transients at the required volume.

During such peaks, the amplifier is driven into an overload condition and as a result the music peaks are 'clipped'. This results in harsh sounding reproduction.

This simple device, which may be built into your existing amplifier, or separately located, flashes a warning light if the power level at which clipping occurs is exceeded.

Two completely independent circuits are provided so that each channel of a stereo system may be monitored separately.



*SEE TABLE 1 FOR VALUES

ONE CHANNEL ONLY SHOWN

Fig. 1. Circuit diagram of overload detector. One channel only shown.

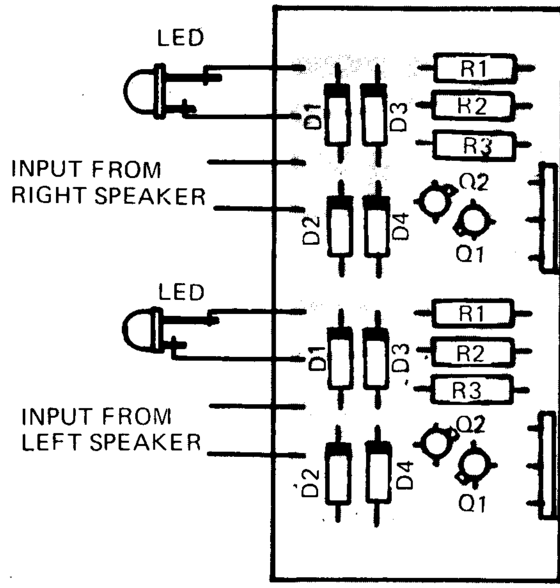


Fig. 2. Component overlay.

HOW IT WORKS

The output of each power-amplifier channel is monitored at the speaker terminals. The output is bridge rectified by D1-D4 so that both positive and negative transients may be detected.

Transistors Q1 and Q2 (together) are equivalent to a sensitive gate SCR (silicon controlled rectifier). If the voltage at the base of Q2 is more than about 0.6 volts above its emitter, Q1 and Q2 will each turn hard on and latch on, until the current through them drops to zero.

When transistors Q1 and Q2 are on, the current flowing through them also flows through the LED causing it to illuminate. Resistor R1 limits the peak current through the LED to about 100 mA. The range of calibration potentiometer RV1 is set by resistor R3. The values of R1 and R3 are provided in Table 1 for various amplifier power ratings and speaker impedances. These values are not critical. If your amplifier has a power rating other than that specified, the nearest values will do.

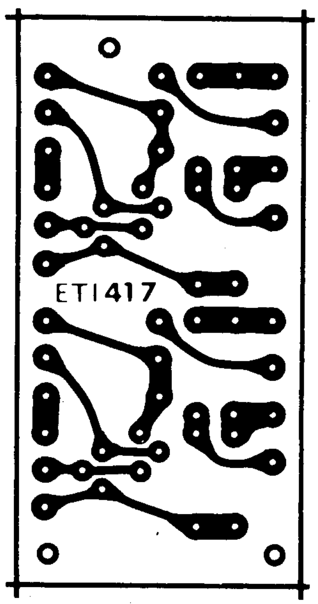
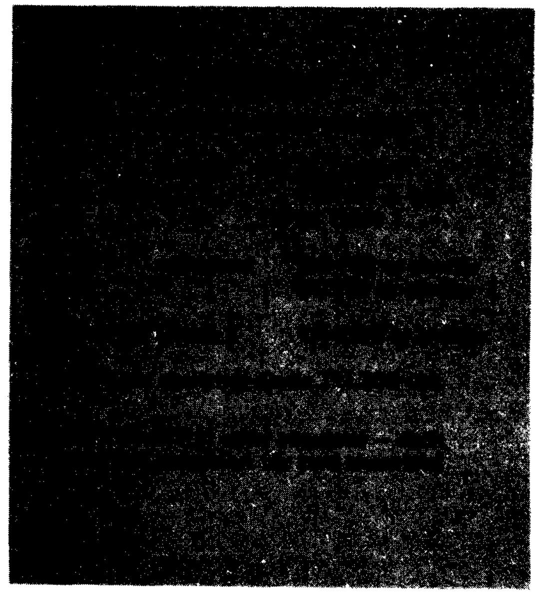


Fig. 3. Printed circuit board (full size).



CONSTRUCTION

Mount all components on to the printed circuit board in accordance with the component overlay. Make sure that all diodes are correctly orientated, in particular the LED's. The LED's will not be damaged by reverse polarity but will not operate in that mode.

Whether the unit is mounted inside the amplifier or external to it in a small box will be a matter for the individual constructor. The printed circuit board may be mounted in any suitable position within the amplifier and leads extended to front-panel mounted LEDs if required.

Polarity of the leads to the amplifier output terminals is immaterial but make sure that the leads of separate channels are not mixed. This is best avoided by twisting each pair of leads to each channel.

CALIBRATION

There are several ways of calibrating the unit.

By far the best way is to connect an audio oscillator to the input of the amplifier (both channels driven at the same time), then, with the amplifier volume control at a low setting, adjust the oscillator to provide a 1 kHz sine-wave.

Set both trim potentiometers (RV1) so that their wipers are nearest R3.

Now increase the amplifier volume until clipping occurs. This is very easily identified as a sudden harshness of tone. Do not leave the volume control at this setting for more than a second or two, as apart from the pounding you are giving to your ears, some amplifiers will not tolerate a sine-wave input at clipping level for extended periods without damage.

Once the clipping point has been established, turn the volume down again, and then quickly turn up to the clipping point momentarily, meanwhile adjusting the trimming potentiometers RV1 until a point is reached where the light emitting diodes just come on.

Repeat the procedure a few times – finally arriving at a setting at which the LED's come on just before the clipping point.

If you do not have access to an oscillator, the device can be set by playing a test record that contains a sine-wave tone – or failing this – by playing a record of a solo instrument such as a flute. A recording of the human voice is also very effective. In such cases the same calibration procedure described above should be followed. ●

Is your amp good enough for digital disc?

Overload indicator for power amplifiers

Just how do you tell if an amplifier is being overloaded by a program signal. Even if the overload condition is very slight, it may cause a deterioration in sound quality while being undetectable when displayed on an oscilloscope. The circuit presented here will detect even slight overload conditions and is not affected by load impedance or varying supply voltages.

by LEO SIMPSON

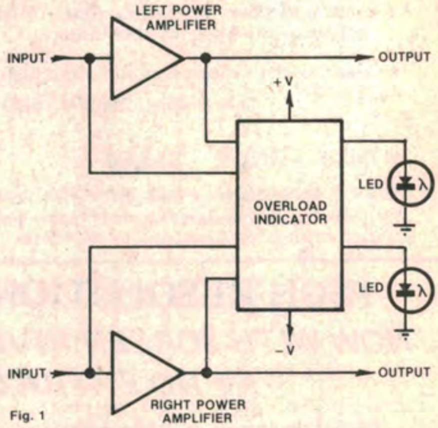


Fig. 1

With the advent of direct-cut records and, more recently, the compact disc, programs with very wide dynamic range are becoming more common. Many amplifiers and loudspeaker systems may not be able to reproduce this wide dynamic range without a strong possibility of overload occuring.

The reason that amplifiers and loudspeakers will be more prone to overload is not because people will necessarily be tempted to turn up the volume to enjoy the signal quality, although that is always a strong possibility. No, the reason is that now we have a recording process (ie, the compact disc) which no longer "crushes" the very large signal transients which normally occur from instruments such as pianos, drums or trumpets.

These instruments can easily generate very large signal peaks just in normal playing and without the volume being at a high level. The resulting brief overload of the amplifier may not be really obvious but it will lead to a deterioration in sound quality.

We must emphasise that one need not be listening at a high sound level for these brief overloads to occur.

Having recognised the possibility that the system may be overloading, where is the overload most likely to occur? In the amplifier or the loudspeakers?

It is fair to say that many systems will be prone to overload of both the amplifiers and the loudspeakers. The first step to eliminating this problem, and achieving the best sound quality which these new signal sources have to offer, is to determine if overloading is occurring in the amplifier.

The two factors which are most important are the amplifier supply rails and the load impedance. Now for a given supply voltage a power amplifier may be able to deliver an undistorted sine wave signal of 80 volts peak-to-peak into a resistive load of eight ohms. This corresponds to a power output of 100 watts RMS. To do this, the amplifier would probably require supply rails of at least ±55 volts or a total of 110 volts DC. The exact voltage required would depend on the particular configuration of the output and driver stages and the operating temperatures of the semiconductors.

On this last point, for example, power amplifiers using Mosfets usually can deliver slightly less power as they become hot whereas power amplifiers using bipolar transistors deliver slightly more power before clipping occurs.

Having determined that an amplifier will deliver a certain maximum output voltage to a resistive load (at a given operating temperature), let us now consider what happens if the amplifier supply voltages are reduced by 5% as may easily occur if the mains voltage is low or if the amplifier has just previously delivered a large burst of power. A 10% reduction of the supply rails will lead to almost 20% reduction in available power output.

In addition, most amplifiers are unable to deliver the same output voltage swing to realistic loudspeaker loads as they can into resistive loads. This applies especially if the loudspeaker impedance dips substantially below the nominal value of, say, eight ohms.

The point of the foregoing discussion is

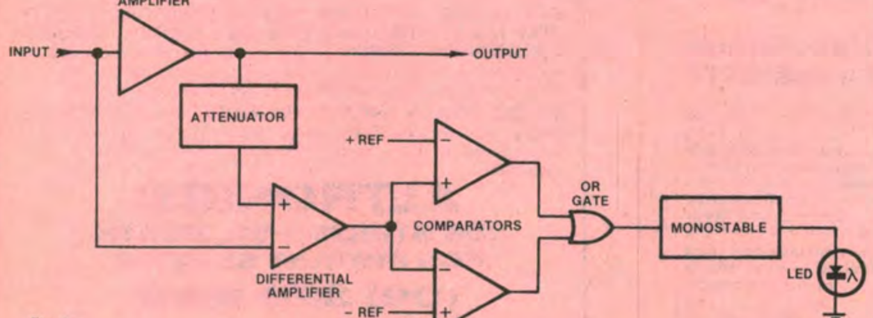
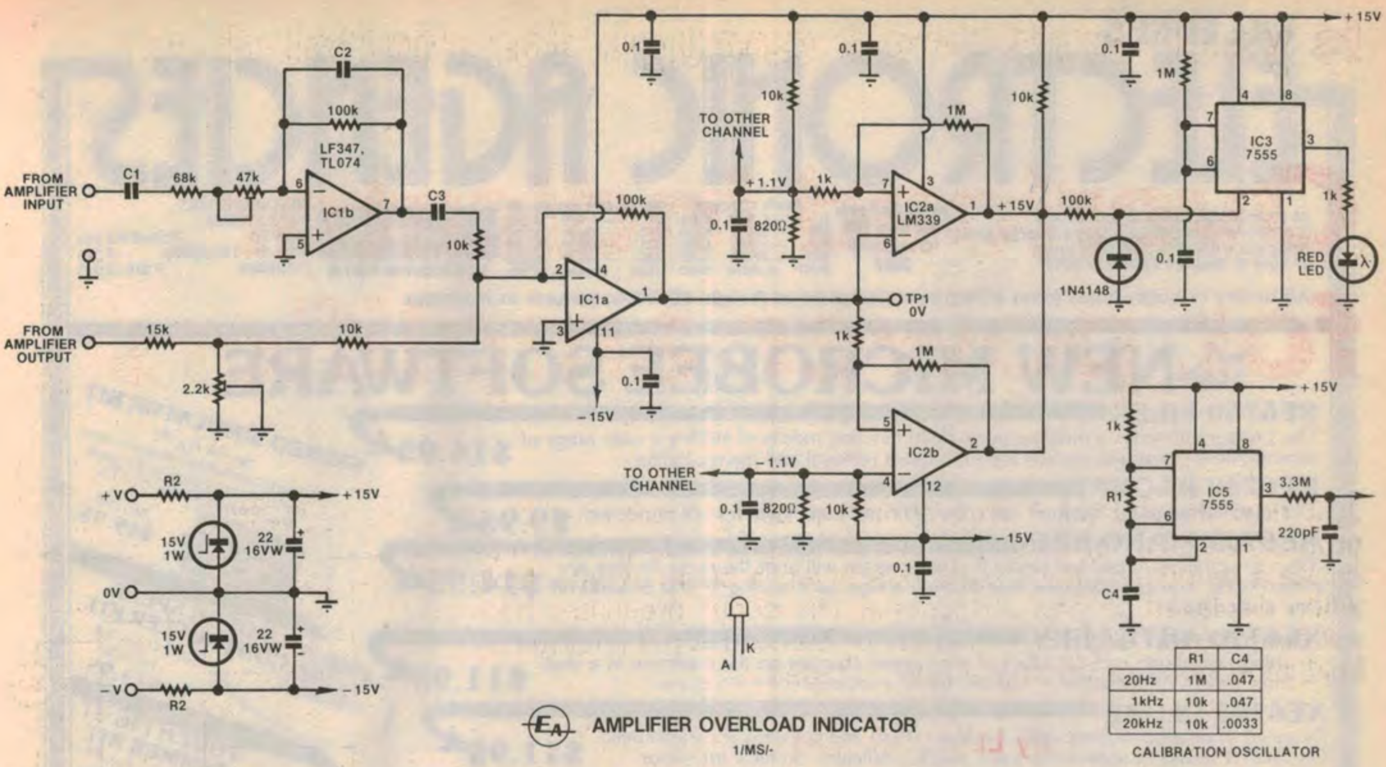


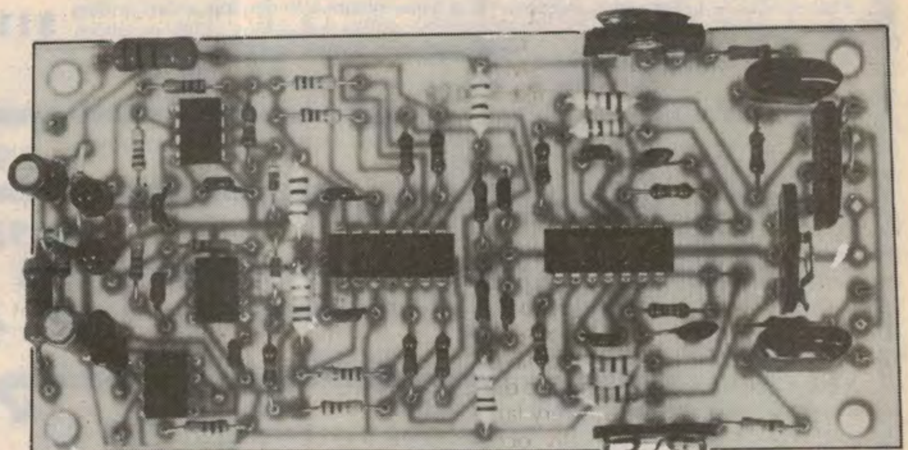
Fig. 2

Fig. 2: basic scheme for the overload indicator (one channel only).



	R1	C4
20Hz	1M	.047
1kHz	10k	.047
20kHz	10k	.0033

The circuit compares the shape of the signal waveform at the input and output of each power amplifier stage.



The PC board is designed to mount inside the amplifier. We installed the LEDs on the board, but they would typically be mounted on the front panel.

to demonstrate that conventional power meters or overload indicators are unable to accurately indicate if an overload is actually occurring. This is because they depend on the assumption that an amplifier can deliver a certain maximum output voltage, come what may. Well, as the song says, "it ain't necessarily so!"

The overload monitor presented here compares the shape of the signal waveform at the input and output of a power amplifier. If there is a difference amounting to a harmonic distortion equivalent of 0.1% or more, the overload indicator will light. Thus the circuit continuously checks the linearity of the amplifier and will immediately light up in the event of clipping, slew rate limiting or a fault condition such as excessive DC offset at the output.

The circuit includes a memory feature so that even very brief overloads lasting perhaps only 25 microseconds (corresponding to one half-cycle at 20kHz) or less will be clearly indicated by a short flash from a light emitting diode.

The overload indicator would also be of particular use with amplifiers used for stage or studio work. It would then avoid the likelihood of repeatedly driving an amplifier into overload which may damage expensive loudspeakers without any harm to the amplifier itself.

As presented, the overload indicator is a printed circuit board measuring 132 x 63mm which is suitable for incorporation into any solid state stereo (or mono) power amplifier which has balanced supply rails. Fig. 1 shows the general scheme of connections from the overload indicator to both channels of a typical stereo power amplifier.

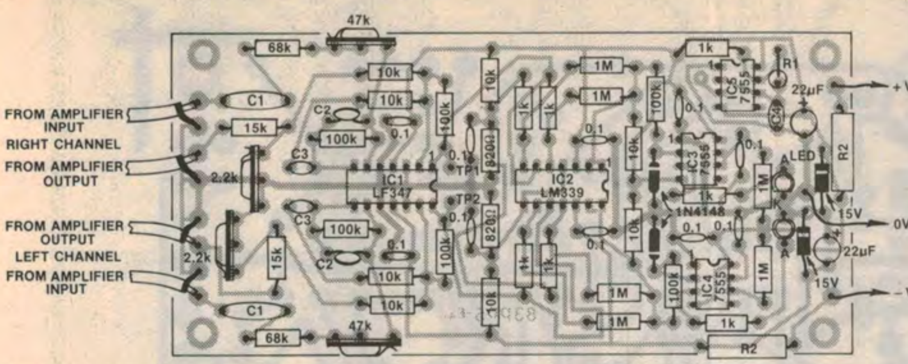
Six connections are required: to the input and output of each power amplifier and to the supply rails. Fig. 2 shows the general concept of how the overload indicator monitors a power amplifier. Only one channel is shown.

Fig. 2 depicts the input and output signal connections from a power amplifier being made to a differential amplifier. The power amplifier's output signal is passed through an attenuator to cancel out the gain of the power amplifier. This means that provided the power amplifier is operating within its linear region (ie, not clipping or otherwise distorting the signal) there will be no output signal from the differential amplifier.

But if the power amplifier is clipping, there will be a substantial difference signal applied to the differential amplifier and it will have a large output signal.

The output of the differential amplifier is coupled to a pair of comparators which sense whether the signal is swinging above or below 0V by more than the comparator reference voltages. If the signal exceeds these limits, the output of one or other of the comparators will go high. The comparator outputs are fed to an OR-gate which has a high output if one or other of the comparator outputs is high. If this happens, the following monostable is triggered and the LED lights.

Overload indicator



Parts overlay diagram for the Overload Indicator. Note that the 3.3Mμ resistor and 220pF capacitor on pin 3 of IC5 are not included on the PC board.

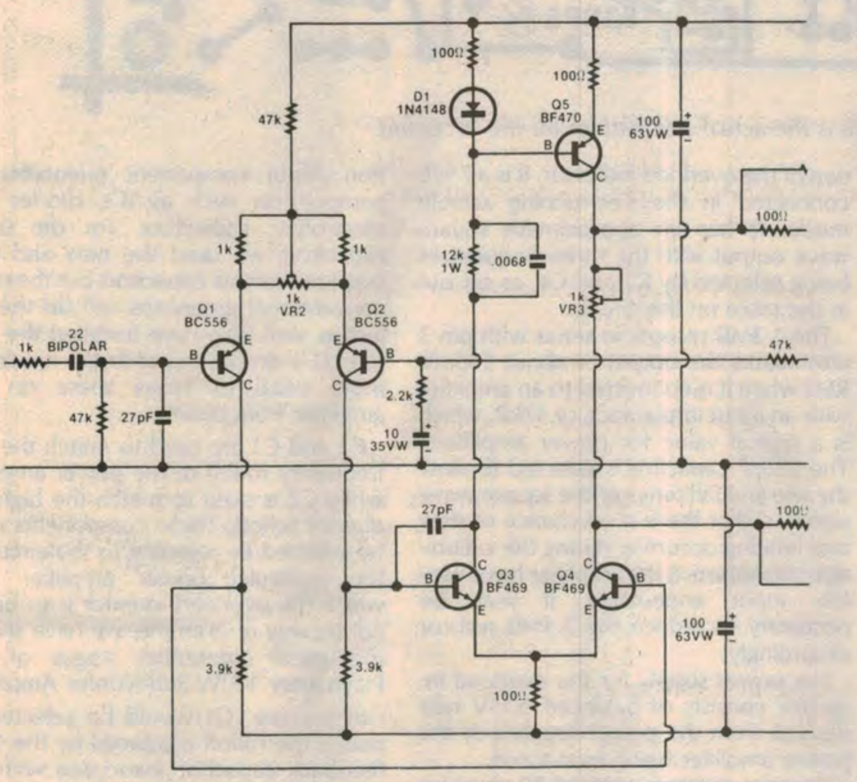


Fig. 3: input differential stages of the Playmaster 100W Sub-woofer Amplifier. See text re selection of C1, C2 and C3 in overload indicator circuit.

PARTS LIST

1 PC board, 132 x 65mm, code 83pp5
18 PC pins
1 TL074, LF347 quad Fet-input op amp IC
1 μA339, LM339 quad comparator IC
3 7555 timer ICs
2 1N4148 diodes
2 15V 1W zener diodes
2 red LEDs

CAPACITORS
2 22μF/16VW PC-mounting electrolytic
10 0.1μF metallised polyester (greencap) or monolithic
1 .047μF metallised polyester or ceramic
1 .0033μF metallised polyester, polystyrene or ceramic
1 220pF ceramic
PLUS: 2 x C1, C2, C3 (see text)

RESISTORS
(5% tolerance, ¼W rating)
1 x 3.3MΩ, 7 x 1MΩ, 6 x 100kΩ, 2 x 68kΩ, 2 x 15kΩ, 9 x 10kΩ, 7 x 1kΩ, 2 x 820Ω, 2 x R2 (see text), 2 x 47kΩ trimpots, 2 x 2.2kΩ trimpots

MISCELLANEOUS
Shielded cable, hook-up wire, PC-mounting hardware, solder.

The foregoing brief description assumes that the power amplifier being monitored is not an inverting amplifier. As it happens, very few power amplifiers do invert the signal polarity (ie, cause a 180 degree phase reversal between the input and output). With those few power amplifiers which do invert the signal, the monitoring circuit could be modified to take care of this problem, by providing an extra signal inversion.

Fig. 2 won't work

For a number of reasons which will become evident as this article progresses, the simple circuit configuration of Fig. 2 has had to be modified quite extensively to make it work as intended. Refer to the complete circuit diagram now and we will discuss its operation. Again, only one channel is depicted.

Instead of using just one differential amplifier as shown in Fig. 2, we have used IC1a and IC1b. IC1b inverts the signal from the power amplifier input so that it will have out-of phase polarity to the signal from the power amplifier output, which is coupled in via an attenuator consisting of a 15kΩ resistor and 2.2kΩ trimpot.

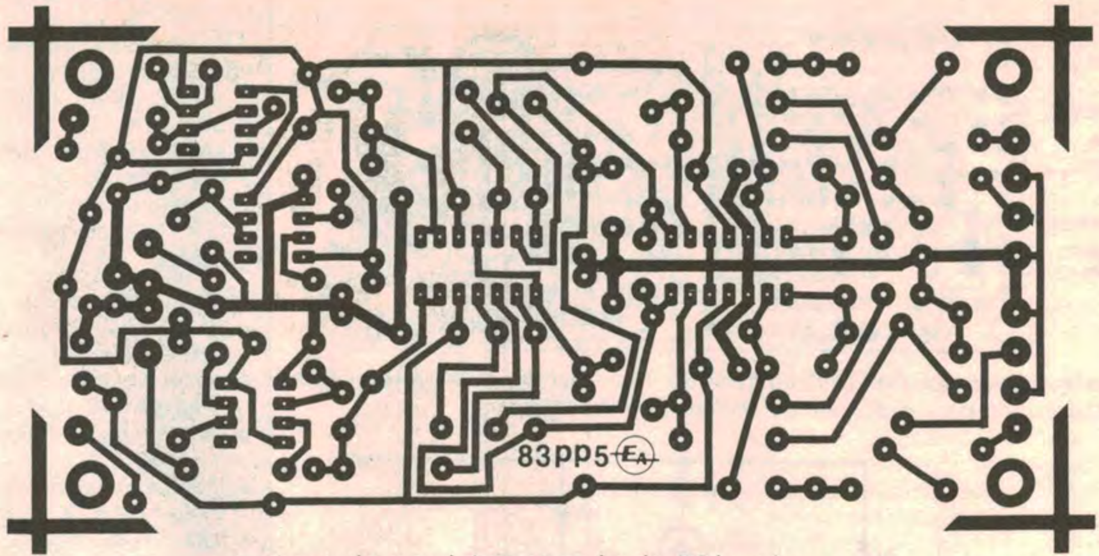
IC1a functions as a "summing" amplifier with a gain of 10. IC1a sums the inverted power amplifier input signal (via IC1b) and the attenuated power amplifier output signal via 10kΩ resistors. Provided the power amplifier is operating linearly, the output of IC1a is 0V.

Following IC1a is a pair of comparators, IC2a and 2b, (actually half of a quad comparator, type LM339). These perform the same function as the comparators in Fig. 2 except that the arrangement of the inputs has been changed. The reasons for this change are several.

First, while the signal to the inputs of the comparators may swing above and below 0V, it is desirable that the outputs swing only between 0V and 15V. This is because the 7555 monostable (IC3) at the end of the signal chain requires a single rail supply and requires a trigger signal which drops to 0V.

The LM339 lends itself to this function particularly well because it has so-called open-collector outputs. This means that the two comparator outputs can be tied together and connected to a common 10kΩ load resistor. This is handy because it provides the OR-gate function shown in Fig. 2. It can be regarded as a so-called "wired-OR" gate.

The consequences of the LM339 input and output connections are that, for comparator input signals of less than ±1.1V (the positive and minus thresholds of the two comparators), the tied outputs will be high (ie, +15V). For input signals greater than ±1.1V, the tied output will be low, at −15V. This is rendered compatible with the input of the following 7555 monostable circuit by the 100kΩ resistor and clamping diode.



Here is the actual size pattern for the PC board.

When the common comparator outputs are low, the clamping diode prevents pin 2 of the 7555 (IC3) being damaged by clamping it to −0.6V. When pin 2 is pulled low in this fashion, pin 3 of the 7555 goes high and lights the LED for about 0.1 second, a period determined by the 1MΩ resistor and 0.1μF capacitor connected to pins 6 and 7 of IC3.

In the event of a DC fault or very severe clipping in the power amplifier being monitored, the comparator outputs will be permanently low. In this case, the output of the 7555 (pin 3, IC3) will remain high and the LED will stay alight.

Why use the "summer"?

As noted above, we had to replace the differential amplifier of Fig. 2 with IC1a and 1b. We found this necessary because we were unable to obtain a good "null" when adjusting the attenuator. The reason for this was insufficient common-mode rejection in the differential amplifier, particularly at high frequencies.

By way of explanation, a differential amplifier is supposed to ignore common mode signals or signals which are the same, and only amplify the difference between the signals applied to its inputs.

So by using inverting amplifier IC1b and summing amplifier IC1a, we solve the problem of insufficient common mode rejection. Even so, it is still necessary to ensure that the high frequency and low frequency rolloffs of IC1b match those of the power amplifier being monitored. To this end, we have included C1, C2 and C3. We will describe selection of these components later.

Two aspects remain to be discussed: IC5 and the power supply. IC5 is provided as an on-board oscillator for calibration of the overload indicator. It is a 7555 connected in the free-running astable mode. It has an approximate square wave output with the three frequencies being selected by R1 and C4, as set out in the table on the circuit.

The 3.3MΩ resistor in series with pin 3 attentuates the output to about 100mV RMS when it is connected to an amplifier with an input impedance of 47kΩ, which is a typical value for power amplifiers. The 220pF capacitor is selected to slow the rise and fall times of the square wave signal so that there is no chance of slew rate limiting occurring during the calibration procedure. If the amplifier has a very low input impedance, it may be necessary to reduce the 3.3MΩ resistor accordingly.

The power supply for the overload indicator consists of balanced ±15V rails derived from the power supplies of the power amplifier being monitored.

The two resistors marked R2 must be selected to suit the rail voltages. For amplifier supply rails between 25V and 35V, R2 can be 680Ω/1W. For voltages between 35V and 45V, make R2 1.2kΩ/1W; between 45 and 50V, make it 1.8kΩ; for 50 to 60V, make it 2.2kΩ/1W; for 60 to 65V, 2.7kΩ/1W and for 65 to 70V, 3.3kΩ/1W.

Construction

Assembly of the PC board requires little comment other than the usual caution about component orientation of components such as ICs, diodes and electrolytic capacitors. For the 0.1μF capacitors we used the new and very small monolithic capacitors but the more conventional greencaps will do the job just as well. We have installed the two red LEDs on the board but it would be more usual to install these on the amplifier front panel.

> We estimate that the current cost of components for this project is approximately
>
> **$20**
>
> This includes sales tax.

C1 and C3 are used to match the low frequency rolloff of the power amplifier while C2 is used to match the high frequency rolloff. These components must be selected by referring to the circuit of the particular power amplifier with which the overload monitor is to be used. By way of example, we have shown the input differential stages of the Playmaster 100W Sub-woofer Amplifier.

In practice, C1 would be selected to match the rolloff produced by the 10μF feedback capacitor associated with Q2 while C3 would be selected to match the effect of the 22μF bipolar input capacitor.

The selection practice is simply a matter of scaling the capacitor values up or down to match the associated resistors. Taking the easiest one first, C3 should have the same impedance ratio to the associated 10kΩ series resistor as does the 22μF bipolar input capacitor to its associated 47kΩ shunt resistor. By that reasoning, C3 should be 4.7 times 22μF or close enough to 100μF.

In this particular case though, the impedance of a 100μF capacitor at, say, 20Hz, is so low that it will cause negligible phase shift. As a result, C3 may be replaced by a wire link, as shown in the photograph in this article.

C1 is selected by a similar process and is related to the 10μF feedback capacitor in the circuit ot the amplifier referred to above. By this process, C1 should have the same ratio to 10μF as 2.2:90. This works out to be 0.24μF. The nearest practical value is .22μF and this can be a metallised polyester type.

C2 is used to match the rolloff at high frequencies produced by input shunt capacitors, feedback capacitors (which would normally be in parallel with the 47kΩ feedback resistor in our example) and output RLC network. Since the total effect of these components is unknown unless you take the trouble of measuring the amplifier, a good starter value for C2 is 10 picofarads. This will be ceramic capacitor.

Note that the 3.3MΩ resistor and 220pF capacitor on pin 3 of IC5 are not mounted on the PC board.

For calibration of the overload indicator you will need access to an AC millivoltmeter (your digital multimeter will do) with good frequency response (to at least 20kHz), or an oscilloscope. For a signal source you can use the onboard oscillator (IC5) or an external sinewave audio oscillator.

First apply power, with no input connections. Check the voltages shown on the circuit and see that they are close to the specified values. Now make the connections to the input and output of the amplifier. One point that should be made here is that the input cable from the power amplifier's input should not have its shield connected to the amplifier's input earth. This is to prevent a possible earth loop situation.

Set the oscillator to 1kHz and adjust the level so that the amplifier is delivering a signal level which would result in several watts being delivered to the load. Do not have the loudspeakers connected otherwise the noise level will be annoying. Adjust the 47kΩ trimpot for about mid-setting and adjust the 2.2kΩ trimpot for a null signal at TP1, ie, the minimum possible signal.

Now set the oscillator to 20Hz and adjust the 47kΩ trimpot for a null. This will alter the gain at mid-frequencies for IC1b and the nulling at 1kHz will have to be repeated by adjusting the 2.2kΩ trimpot. In turn, this will require a readjustment of the 47kΩ trimpot at 20Hz. Finally, set the oscillator at 20kHz and check for a null at TP1. If the null is not as good as obtained at the two lower frequencies, the value of C2 may have to be changed.

If the power amplifier is stereo, these tests now have to be repeated for the other channel. Then finally, when tests are complete, disable IC5, the oscillator, by removing R1.

Now reconnect your loudspeakers for listening tests. If the LED indicators light during these tests you will have to make sure that your amplifier volume control is set to a lower level in future. Either that, or you have to buy a bigger amplifier.

Audio overload monitor

This circuit uses two of the four comparators in an LM339 package to provide detection of excessive positive or negative signal peaks. Pulse-stretching is used to ensure that a clear indication of short-duration peaks is given. Bidirectional peak measurement is important as positive and negative peaks may vary by up to 8dB.

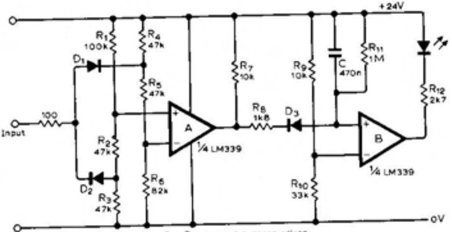
Comparator A detects peaks of either polarity, and the two potential dividers hold the inverting input 400mV below the non-inverting input. If the audio input exceeds the trip point on a positive peak, D_1 conducts which pulls up the inverting input and causes the comparator to change state. Likewise, a suitably large negative peak will make D_2 conduct and pull down the non-inverting input, again causing the comparator output to go low.

When output A goes low, storage capacitor C charges rapidly through D_3 and R_8. When the peak is past, C remains charged and keeps the output of comparator B low so the l.e.d. remains on. The output goes high again after C has discharged through R_{11}, and the l.e.d. is extinguished.

With the values shown, the circuit trips at a peak level equivalent to a 5V r.m.s. sine wave. This is 3dB below the maximum voltage swing to be expected from an amplifying stage operating from a 24V rail. Note that the circuit should not be driven from a high impedance point because the diodes may cause distortion.

A stereo version may be conveniently made using a single LM339 package.

D. Self,
London E.17.



D_1–D_3 general purpose silicon