DI COMPRESSION GATE

The first ETI Sound Processor is a unit combining compressor, noise gate and direct inject box, designed by Allan Bradford of Time Machine Sound Engineering.

The combination of compressor and noise gate is a useful one. The 'pumping' noise associated with high levels of compression can be eliminated by the gate, while the 'topping and tailing' facility afforded by the compressor makes the gate an excellent feedback-killer for PA systems. Comprehensive envelope shaping of sounds for special effects is also possible.

The compressor has a wide range exponential control characteristic which produces a smooth response in the management of 'peaky' signals, with full control over release or recovery time. Attack time is preset for general use, but a front panel screwdriver adjustment enables it to be slowed to allow 'punch-through' effects. Subsequent stages in the audio chain are still protected from overload by an independent fast limiter riding 12 dB above the compression threshold. Gain reduction and limiting are displayed on four LEDs.

The Noise Gate has an attack fast enough for drum kits (but can be slowed right down for 'violating' sounds) and release time is fully variable to suit the program material. An internal time constant eliminates modulation of the signal due to individual waveforms when short release times are employed. The depth of noise-gating is preset at −60 dB but again a front panel screwdriver adjustment permits this to be softened.

Side-chain inputs are provided both for control of compression (for voice-over effects and 'de-essing' and for triggering the noise gate. Two compression gates can be cross-linked for stereo operation.

Inputs are low impedance microphone level and outputs are line level. Inputs and outputs can be balanced or unbalanced via jack or XLR sockets. The unit uses an external power supply for reasons both of economy and hum prevention. Inputs are also provided for direct injection of instruments and of amplifier loudspeaker outputs. The latter will be of particular interest to guitarists wishing to exploit the sound of valve amplifiers while maintaining complete isolation from other instruments. At 1M0 impedance the DI inputs place negligible load on any instruments plugged into them — particularly important if a guitar is to be plugged into the line input, in order to preserve the natural sustain of the instrument. A parallel line jack is provided in order simultaneously to connect the instrument to a monitor amplifier.

A switch is provided to reduce the overall sensitivity of the unit by 10 dB. With the compressor RELEASE knob pushed in the compression gate is matched to −10 dBm line and mic level signals. With it pulled out the unit is matched to 0 dBm line and mic levels.

Two parallel output jack sockets are provided, allowing simultaneous connection to more than one piece of equipment without the need for splitters. These outputs are line level and are unbalanced. A balanced XLR line level output is also provided.

Cold Compressor

The compressor controls the maximum signal level by reducing gain progressively above a certain fixed level known as the threshold. Most sounds fluctuate in amplitude and the effect of compression is to reduce the size of signal peaks and to boost average signal level relative to the peaks (Fig. 1). The dynamic range of the signal is therefore reduced, and this can have several important applications.

LIMITING: This means protection from overload by suppression of unacceptable transients. The ATTACK preset is usually set not quite fully anticlockwise (around 1ms) — but for maximum overload protection in critical applications it may be turned fully anticlockwise,

running the risk of LF distortion. The GAIN/COMP control is advanced so that one or two green LEDs flicker on with the peaks of the music. The RELEASE control should be set about one quarter turn clockwise (about 0.25s). Avoid simultaneous short attack and release times. Release time should be sufficiently long to avoid individual peaks modulating the signal as a whole, with a resultant rasping distortion.

LIFTING VOCALS: Human voices can have a very wide dynamic range and the average level may be substantially below the peak level. By compressing vocals the average level may be boosted so that they become audible in a mix. Compression should be applied to vocals subtly (around 10dB). Too much can make them flat and lifeless.

RECORDING: The human ear can happily accommodate sounds with a dynamic range of 120dB, while the dynamic range of tape recordings is often only 60dB or so. To make maximum use of tape, without quiet sounds being lost in noise and loud sounds saturating the tape and distorting, some compression of signals with a large dynamic range is desirable.

'Thin' or 'peaky' sounding recordings can be salvaged, percussion, for example, often sounding more solid. 'Mix thickening' can be used to increase the average sound level and obtain the sort of impact demanded in modern commercial sound recording. It's used particularly in recording advertising jingles and dico music.

SUSTAIN: The compressor may be used to add artificial sustain to instruments (Fig. 2). The gain is wound right up but the compressor clamps the output signal at compression thresholds. Only when the amplified signal falls below this level of the compression threshold will the signal resume its natural decay. RELEASE should be kept short and the GAIN/COMP control advanced to give the required degree of sustain.

It is also possible to combine sustain with a 'punch-through' attack by allowing the amplified signal to pass unattenuated for a short time before compression takes over. Set the ATTACK preset and RELEASE control to around mid-position. The fast limiter will prevent excessive excursions of the signal but 12dB of punch-through is still available to preserve naturally percussive sounds or add percussion to softer sounds.

Other Features

The four LEDS form a reverse driven bargraph. The right hand LED indicates up to 10 dB of gain reduction. With this LED on and the next LED flickering, gain reduction is in the region of 10 to 20dB. Two green LEDs on and the yellow LED flickering indicate up to 30dB of gain reduction. The leftmost red LED shows that the fast limiter is working, handling transisents too fast to be controlled by the compressor (Fig. 3).

A two-pole jack socket is wired with the tip as a control input and the ring as a signal output for external connections to the compressor. A standard mono jack may be used. The socket may be used either as a control input or as an insert point. A line level signal fed to the EXT COMP socket will cause a reduction in the level of a music signal passing through the compression gate ordinarily. This allows voice-overs or 'ducking' effects to be achieved easily — one signal controlling the level of one or more others.

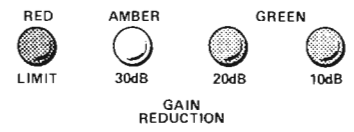


Fig. 3 The compressor LED display.

As an insert point, the EXT COMP socket can be used to introduce equalisation into the control path for 'de-essing' and 'de-popping', which are dealt with below.

Noises off

A common hazard of recording and public address work is the inclusion of unwanted sounds in the mix, such as guitar amplifier noise, hum from keyboards, tape hiss, low level RF pick up or 'spillage' of sound from one microphone into other microphones. The problem is aggravated by the high gains associated with large amounts of compression.

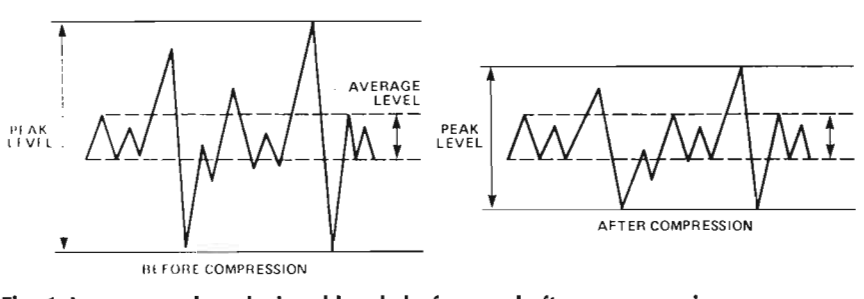


Fig. 1 Average and peak signal levels before and after compression.

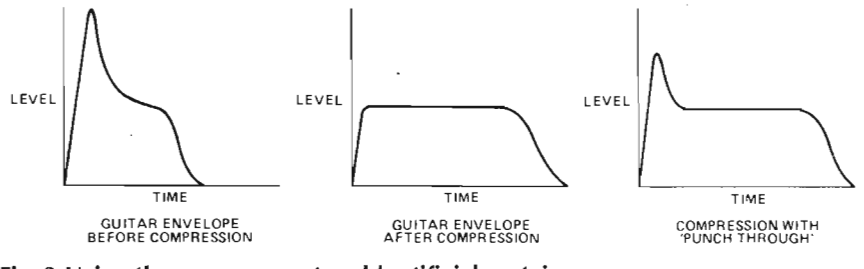


Fig. 2 Using the compressor to add artificial sustain.

BUYLINES

A complete kit of parts including the fully finished steel case and associated hardware is available from TIME MACHINE Sound Engineering for £68.00 including VAT, postage and packing. The double sided, legended PCB is available separately at £9.00 and the case at £14.00. The ready built power supply in a plug costs £24.00. A stereo pair with dual power supply and a cross-linking lead costs £154.00 in kit form. All prices include VAT, postage and packing. Contact:

TIME MACHINE Sound Engineering, Abbotsford, Deer Park Avenue, Teignmouth, Devon TQ14 9LJ. Telephone 06267 2353.

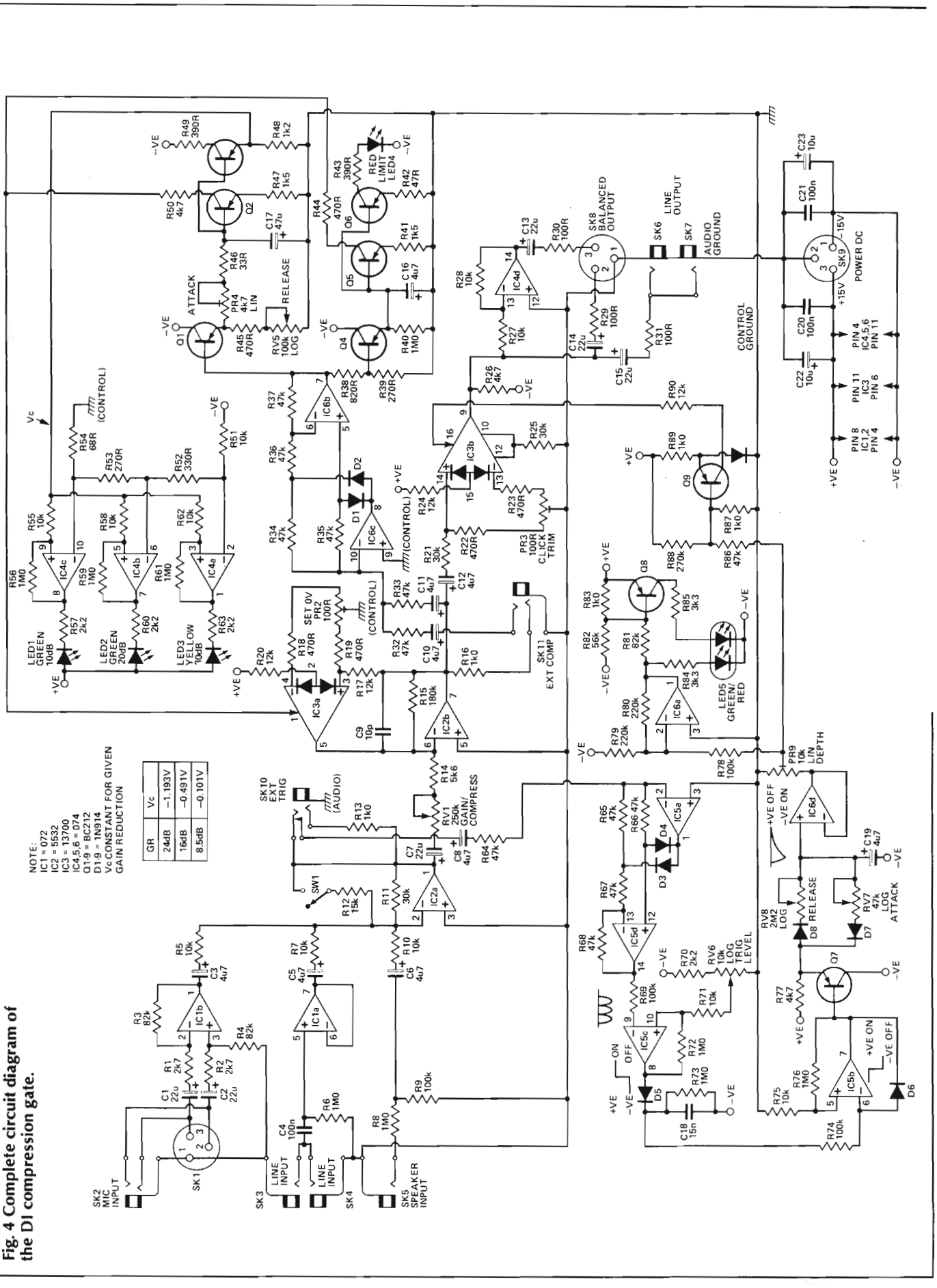


Fig. 4 Complete circuit diagram of the DI compression gate.

HOW IT WORKS

Microphone inputs are debalanced by differential amplifier IC1B which has a gain of 30 dB, while line level signals are buffered by high impedance follower IC1a and loudspeaker level signals are attenuated by 20dB by R8 and R9. The resulting matched signal levels are summed by IC2a, the gain of which is switched between 0 dB and + 10 dB by SW1.

The compressor is centered on IC2b and OTA IC3a which together form a voltage controlled amplifier, the quiescent gain of which is set by RV1. Current flowing into IC3 pin 1 increases the negative feedback around IC2b and so reduces the overall gain of the system. From here the signal passes through the noise gate VCA constructed around the other half of IC3 (unless this is by-passed by SW2) and thence to the outputs, where IC4d provides an antiphase signal for the other half of the balanced output. PR2 and PR3 are used to minimise control breakthrough in the two VCAs.

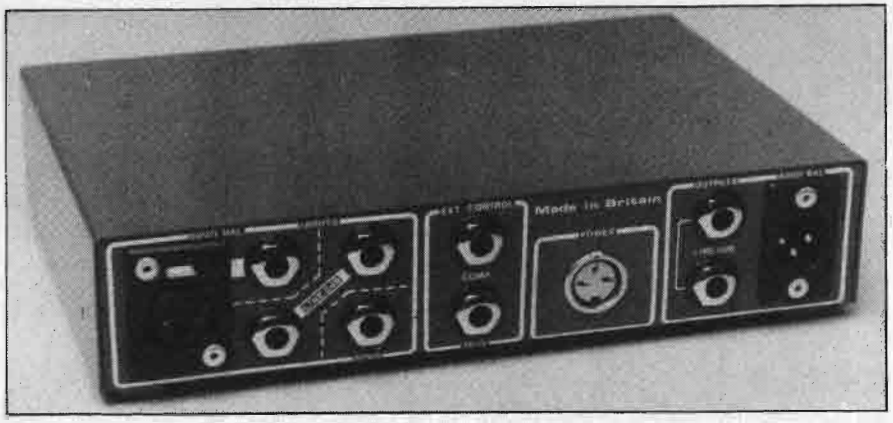
The signal at the output of the compressor VCA (IC2 pin 7) is full wave rectified by IC6b and c. If this rectified signal is larger than the voltage drops associated with Q1 and Q2 then current flows into the control pin of IC3a to reduce the gain, and it is this voltage drop which constitutes a threshold above which the signal is compressed. The bigger the signal tries to get, the harder Q2 is turned on, the more current flows and the more the gain is reduced. The closed loop system thus formed makes for very stable control of level which is unaffected by temperature. The exponential control characteristic of Q2 means that the compression ratio (change-in-input-dB/change-in-output-dB), nominally 5:1, actually increases with compression giving a very 'musical' operation over a wide 30dB range of compression. The response and recovery times are set by PR4 and RV5. Q3, R48 and R49 generate a control voltage Vc proportional to the control current and therefore to the amount of gain reduction, and this feeds the bargraph driver built around IC4a, b and c.

A second side chain with fixed time constants is built around Q4 and Q5. With its input subject to a 12dB attenuation (R38 and R39) it provides the limiter function and responds very quickly to transients, dumping large currents into IC3a pin 1. Q6 drives LED 4 to indicate operation. SK11 allows external signals to control the compressor, or equalisation to be introduced into the side chain.

The signal from IC2a (prior to the compressor) is full wave rectified by IC5a and d and then compared with a reference voltage set by the TRIG LEVEL pot RV6. If the signal exceeds this level the output of Schmitt trigger IC5c goes high and the output of IC5b goes low. The time constant introduced by D5, C18 and R72 prevents IC5b being toggled by individual cycles of the signal waveform. Q7 is included to increase the current output of IC5b in order to achieve attack times as short as 40μsec. The low leakage capacitor C19 is discharged by the ATTACK pot RV7; once the signal falls below the level set by RV6 and IC5b goes high again, C19 charges back up towards 0V via RELEASE pot RV8 and R77. The resulting envelope, buffered by follower IC6d and at a level set by the DEPTH preset PR9, controls the noise gate VCA IC3b, via current source Q9. IC6a and Q8 drive the green and red halves of the tricolour LED in opposite senses to provide indication of gate status. SK10 allows an external signal to be substituted into the noise gate side chain, or for the internal signal to be looped through an external processor.

By careful attention to maximum signal levels at the input to IC3b as determined by the compression threshold, an optimum trade off between distortion and signal to noise ratio is achieved, as shown in the specification.

Signal grounds and ground lines in which control currents flow are kept separate on the PCB, joining only where the power supply arrives on the board and is decoupled.



A noise gate discriminates between 'signal' and 'background', shutting down the audio channel in the absence of a useful signal. The level at which the gate opens is set by the Trig Level control. With a useful signal present, turn the control anti-clockwise from fully on until the gate opens. The sound will become audible and the LED indicator will turn from red to green.

The speed with which the gate opens when a signal exceeds the threshold is set by the ATTACK pot. When this is fully anti-clockwise the gate will open within one half-cycle at 10 kHz — fast enough for the sharp transients of drum kits. For vocals, the ATTACK control should be advanced to about one quarter turn clockwise, slowing the attack slightly and avoiding a faint click as the gate opens. The speed with which the gate closes is set by the RELEASE control. This may be set fully anti-clockwise for a sharp cut-off, or advanced clockwise to provide a fade-out which compliments the natural decay of the signal.

Depth is preset to give 60dB attenuation when the gate is closed, but may be adjusted with a screwdriver down to zero.

Softening the attenuation makes the effect of gating more subtle and also allows the noise gate to be used as a 'two-level device' for controlling monitoring levels during recording.

Other Features

A tri-colour LED shows red for closed, green for open and varying shades of amber in between these states. It also responds to the DEPTH preset, turning slowly from amber to green as this preset is turned anti-clockwise.

A two-pole jack socket is wired with the tip as a trigger input and the ring as a signal output for external connections to the noise gate. A standard mono jack plug may be used. This socket can be used as a straightforward trigger input in which an external signal turns on the gate or as an 'insert point' — for example, to introduce equalisation into the control path so that the gate only opens to signals of the desired frequencies. This latter technique will improve the ability of the noise gate to discriminate between wanted and unwanted signals.

A signal passing through the compression gate may have its envelope substantially modified as

outlined above. The noise gate controls can be used to further modify envelopes. Slowing the gate ATTACK gives a gradual start to sounds while a fast RELEASE gives an abrupt finish to sounds. This latter technique is often used to cut off the 'flap' or reverbera-

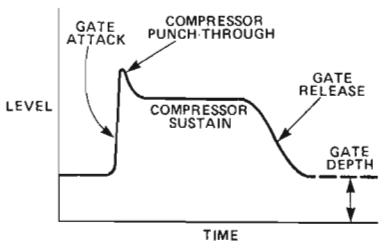


Fig. 5 The parameters defining the shape of the sound envelope.

tion of drums, giving greater impact to the sound.

The parameters available are shown in Fig. 5 and resemble those of ADSR envelope shapers found on sound synthesizers.

Feedback Suppresion

If the overall gain of a PA system exceeds a critical level, the criteria for oscillation are met and

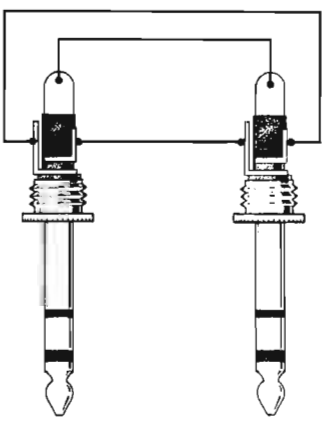


Fig. 6 Wiring of the lead required for stereo operation using two compression gates.

a loud tone is generated. PAs are often used in frequency-selective environments and the feedback generally occurs at a discrete pitch — the resonant frequency at which system gain is highest.

Compression can help by getting rid of large pulses of sound pressure which would shock the system into oscillation. In the absence of a useful signal, however, the gain of a compressor rises and feedback can 'creep up', resulting in howl-round even during periods of apparent silence. The noise gate overcomes this problem and microphones may be operated with between 6 and 10dB more gain than otherwise.

Special Patches

STEREO OPERATION: A pair of compression gates may be cross-linked for stereo operation using a stereo jack to jack lead wired as shown in Fig. 6, with one end being plugged into each EXT COMP socket.

STEREO DE-ESSING: Incoming left and right signals should be mixed and then passed through an equaliser. This equalised signal is fed into the EXT COMP input of each compression gate. A treble boost will cause low frequency components to be compressed most for suppressing 'rumble' or microphone 'popping'. In each case adjust the GAIN/COMP con-

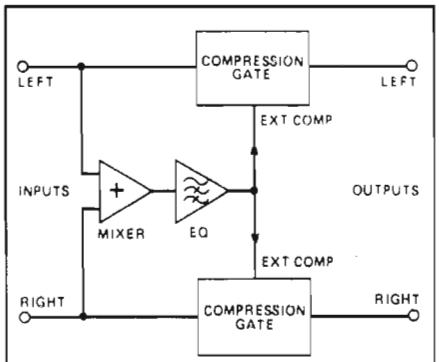


Fig. 7 stereo 'de-essing' arrangement for removing excessive sibilance.

PARTS LIST

RESISTORS (1% metal oxide)	
R1, 2	2k7
R3, 4, 81	82k
R5, 7, 10, 27, 28, 51, 55, 58, 62, 71, 75	10k
R6, 8, 40, 56, 59, 61, 72, 73, 76	1M0
R9, 69, 74, 78	100k
R11, 21, 25	30k
R12	15k
R13, 16, 83, 87, 89	1k0
R14	5k6
R15	180k
R17, 20, 24, 90	12k
R18, 19, 22, 23, 44, 45	470R
R26, 50, 77	4k7
R29, 30, 31	100R
R32, 33, 34, 35, 36 37, 64, 65, 66, 67, 68, 86	47k
R38	820R
R39	270R
R41, 47	1k5
R42	47R
R43, 49	390R
R46	33R
R48	1k2
R52	330R
R53	270R
R54	68R
R57, 60, 63, 70	2k2
R79, 80	220k
R84, 85	3k3
R88	270k
RV1	250k lin pot
PR2, 3	100R min horiz preset
PR4	4k7 vert cermet preset
RV5	100k log pot with push/pull SPST switch
RV6	10k log pot with DPDT switch
RV7	47k log pot
RV8	2M2 log pot
RV9	10k vert cermet preset

CAPACITORS	
C1, 2, 7, 13, 14, 15	22u 16V minelect
C3, 5, 6, 8, 10, 11, 12	4u7 40V minelect
C4, 20, 21	100n polyester
C9	10p ceramic
C16, 19	47u 16V tantalum
C17	47u 16V minelect
C18	15n polyester
C22, 23	10u 40v minelect
SEMICONDUCTORS	
IC1	TL072
IC2	NE5532
IC3	LM13700N
IC4, 5, 6	TL074
Q1-9	BC212L
D1-9	1N914
LED1, 2	Green standard LED
LED3	yellow standard LED
LED4	red standard LED
LED5	Tricolour round LED
MISCELLANEOUS	
SK1	Female panel mounting XLR
SK2, 10, 11	Stereo break ¼" jack socket
SK3, 4, 5, 6, 7	Mono ¼" jack socket
SK8	Male panel mounting XLR
SK9	Prof 3-pin DIN panel socket
SW1	see RV5
SW2	see RV6

Knobs (collet or grub screw, 5off); PCB; case; stick-on cabinet feet (4 off); PCB pillars (tapped and studded plus nuts, bolts and locking washers, 4 off); PCB linking pins (63 off); Veropins (35 off), self tap screw (no 4 x 6 mm, 4 off); 6BA nuts, bolts and locking washers (4 off); power supply ±15V at 120 mA per rail regulated.

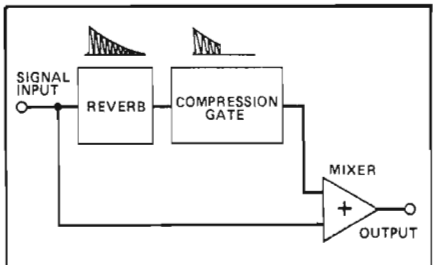


Fig. 8 Using the gate to provide sharply cut-off reverberation.

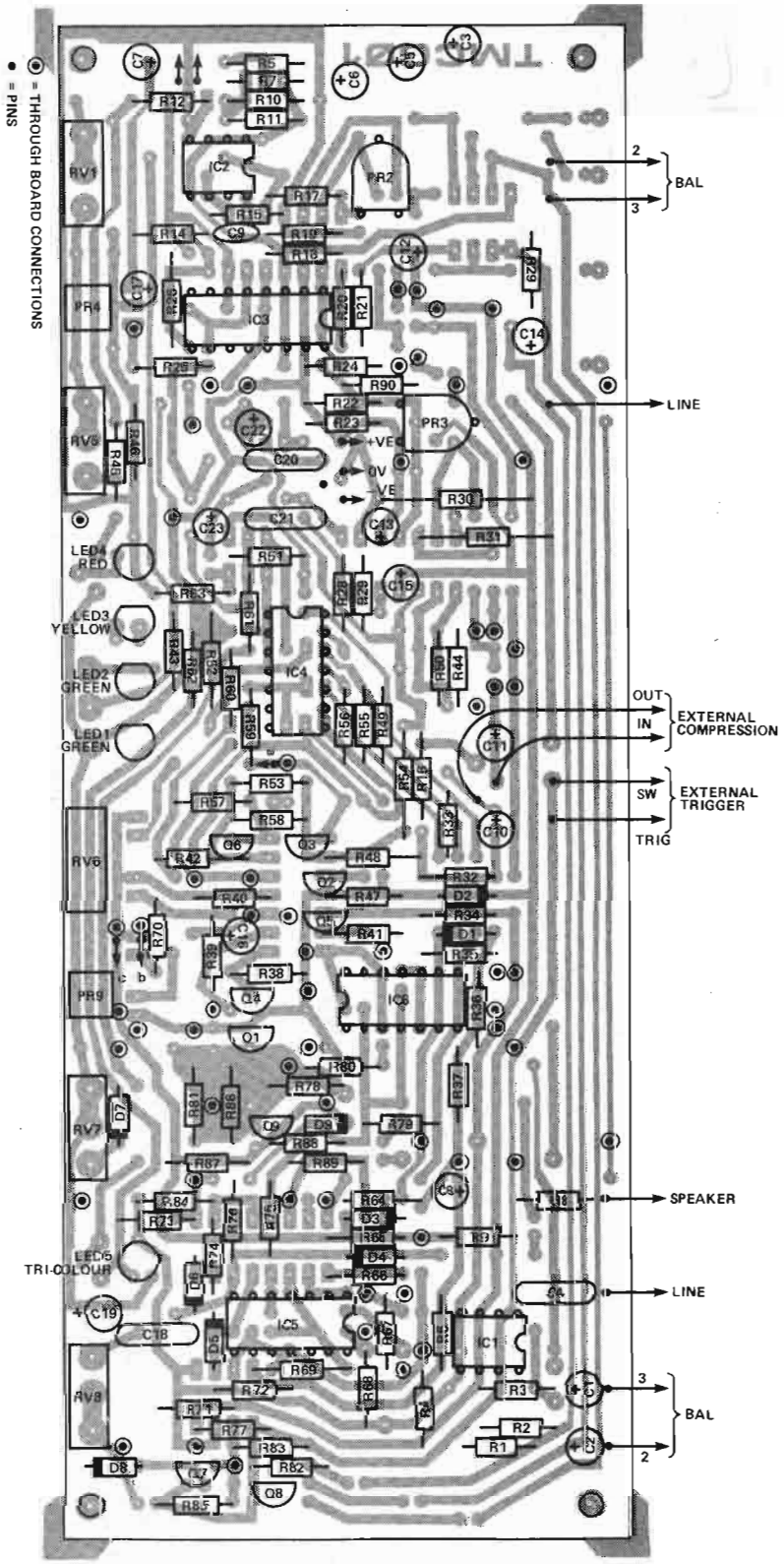


Fig. 9 Component overlay of the compression gate PCB.

trol for the best results, keeping the compressor RELEASE time short so as not to compress the section following the offending sibilant.

GATED REVERB: With the gate RELEASE fully anti-clockwise, adjust the gate Trig Level so that the reverberation cuts off prematurely and abruptly. This is particularly effective on drums (Fig. 8).

EXTERNAL GATE: Sending a signal into the EXT TRIG socket enables that signal to trigger

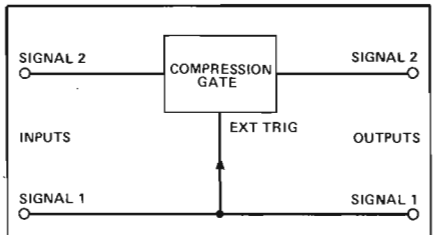


Fig. 10 External gating of the unit to provide voice-over effects.

whatever sound is passing through the compression gate. Softening the gate DEPTH by turning the preset anti-clockwise makes the nosie gate a 'two-level device'. This is the complement of the compressor voice-over patch, in which the presence of a signal at the EXT TRIG input switches the signal passing through the compression gate from attenuated to full (Fig. 9).

Construction

The PCB is double sided and linking pins are used to make the through-board connections, their positions being marked by stars printed on the component side of the board. Great care should be taken to ensure that every pin is soldered on both sides of the board — work systematically and check thoroughly as nine out of ten faults will be found to be due to a pin not being soldered somewhere, usually on the underside of the PCB.

Solder components in order of height: resistors, diodes, IC sockets, presets, transistors, capacitors, LEDs and pots. Take care to observe polarity of diodes and capacitors as marked. It helps if the LEDs are the correct way round, too. The LED leads should be bent at 90°, 5mm behind the plastic package and soldered so that the bends are 5 mm above the PCB.

Note that the Alps pots supplied with the kits solder to

pins in order to be the correct height above the board. Solder Veropins in the pot positions and attach the PCB mounting pillars to the board corners using the studded ends and nuts, then fix the PCB inside the case by passing four bolts through the mounting holes in the bottom of the case. Next cut the pot spindles to length (10 mm) and mount them on the front panel. The pot tags can now be soldered to their respective pins and perfect alignment is ensured. The whole assembly may

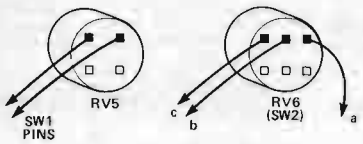


Fig. 11 Wiring of the switches on RV5 and RV6.

now be removed from the case for testing.

Pins should also be used for the off-board connections as well as the connections to the switches on RV5 and RV6 (Fig. 10). Connections to the sockets are shown in Fig. 11 but it is probably wise to complete the setting up and to bench test the completed board prior to wiring it into the case.

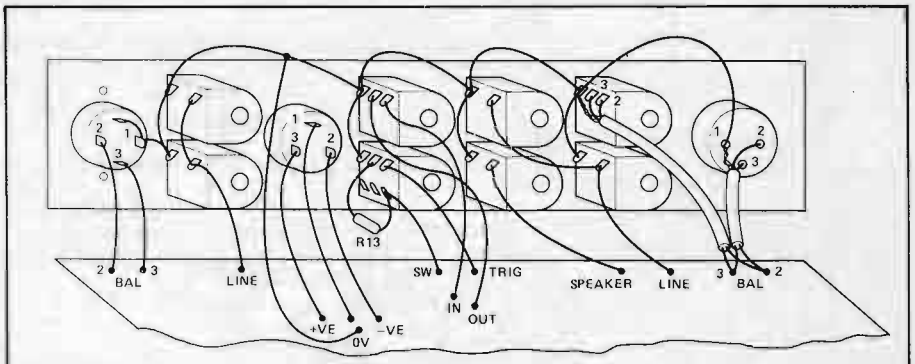
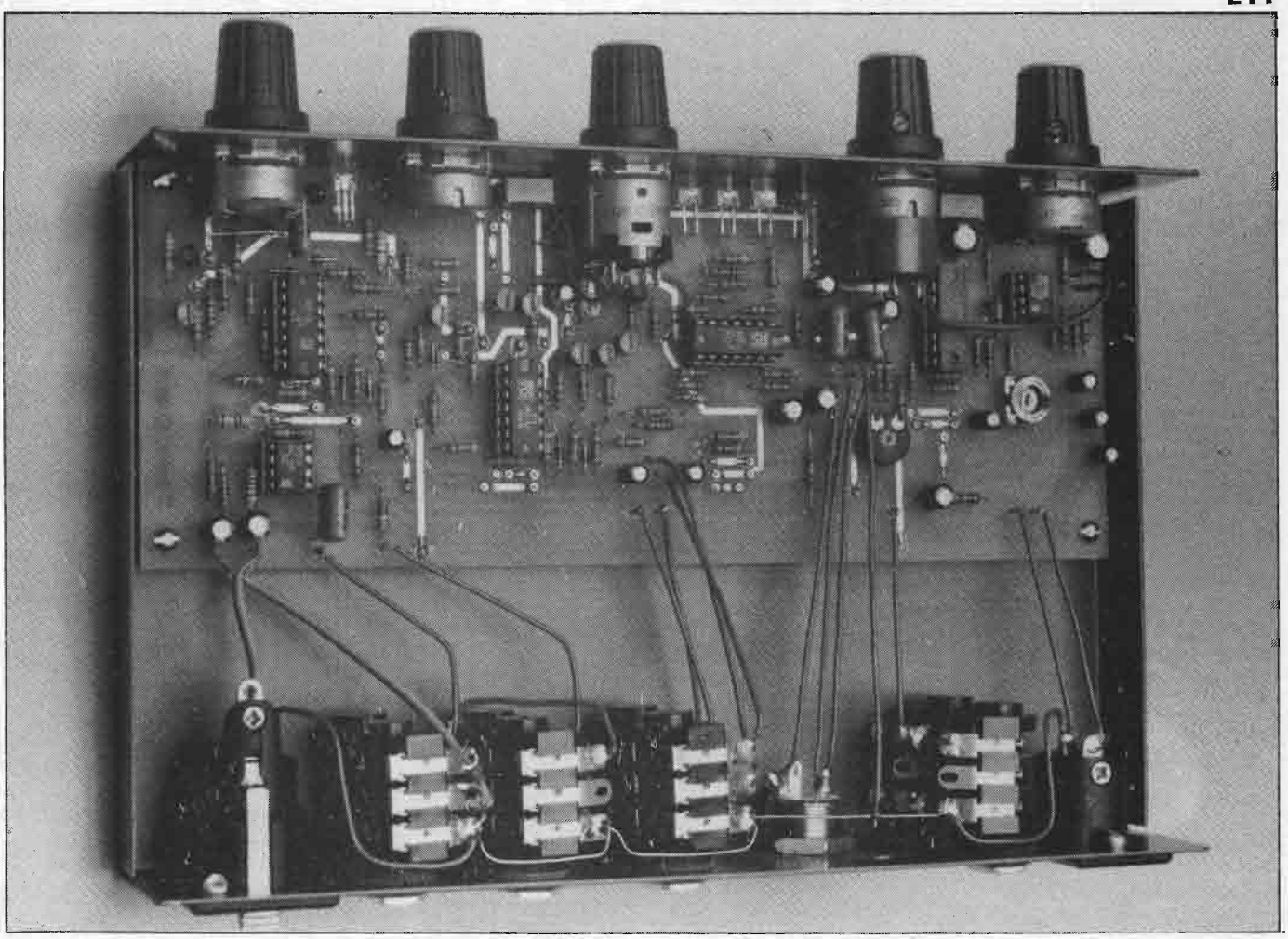
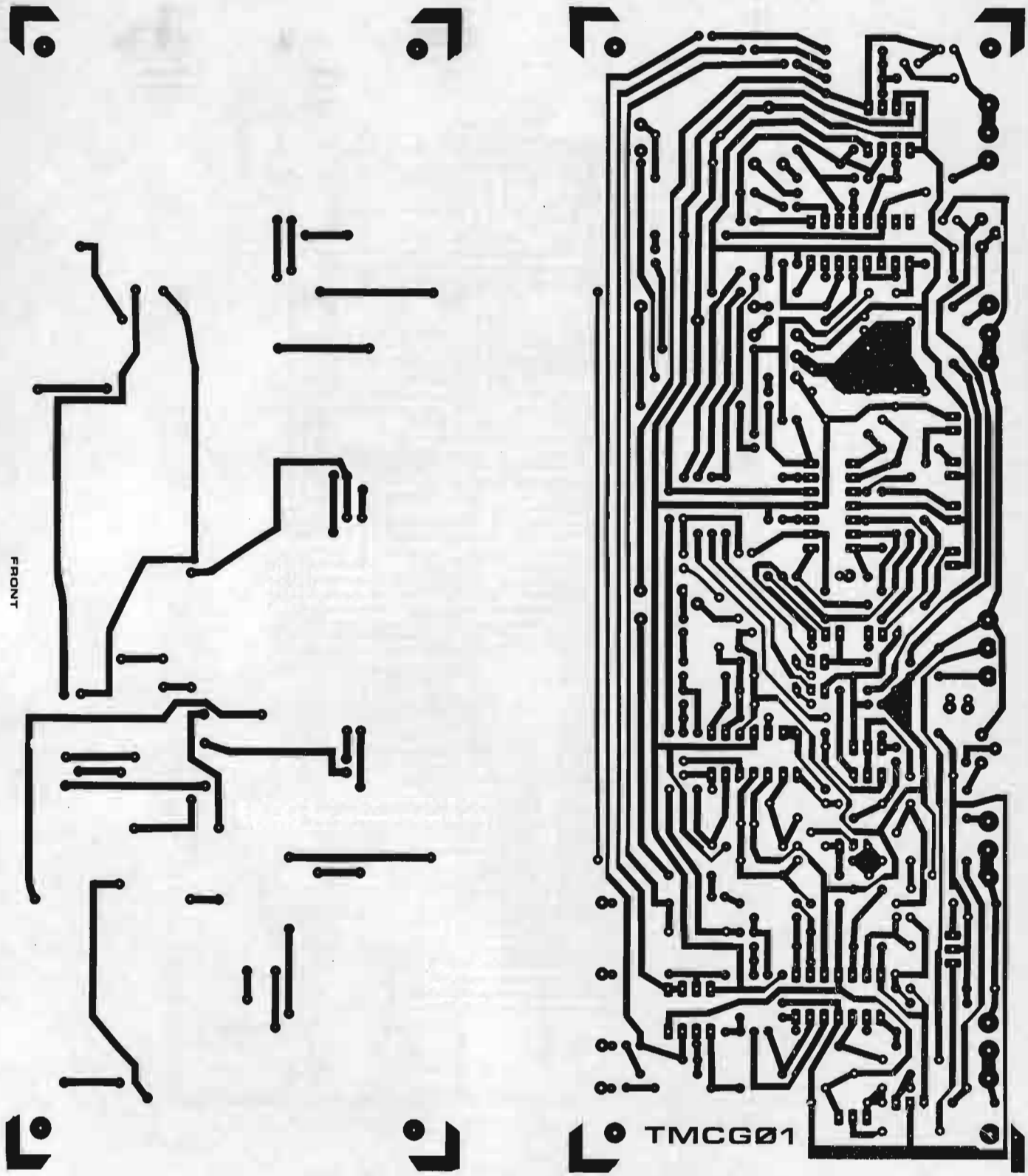


Fig. 12 Wiring of the connectors on the rear panel.

The DI compression gate is designed to run from any regulated power supply providing ± 15V at up to 120mA per rail. A custom power supply built into a mains plug case and with a 2metre lead terminated in a 3-pin DIN plug is available from the kit manufacturers.

The only setting up required is of the two presets RV2 and RV3. Using a voltmeter on its most sensitive range, adjust RV2 to set IC2 pin 7 to precisely 0V. Next set gate ATTACK and RELEASE at minimum and the DEPTH preset fully clockwise, then either feed a sine wave into a line input or use a microphone in order to trigger the Noise Gate — adjust the THRESHOLD control so that the gate opens and closes as the incoming signal goes up and down in volume. A click will be heard as the gate opens and closes and RV3 should be adjusted until this is minimized. **ETI**





The top and bottom foils for the DI compression gate board.