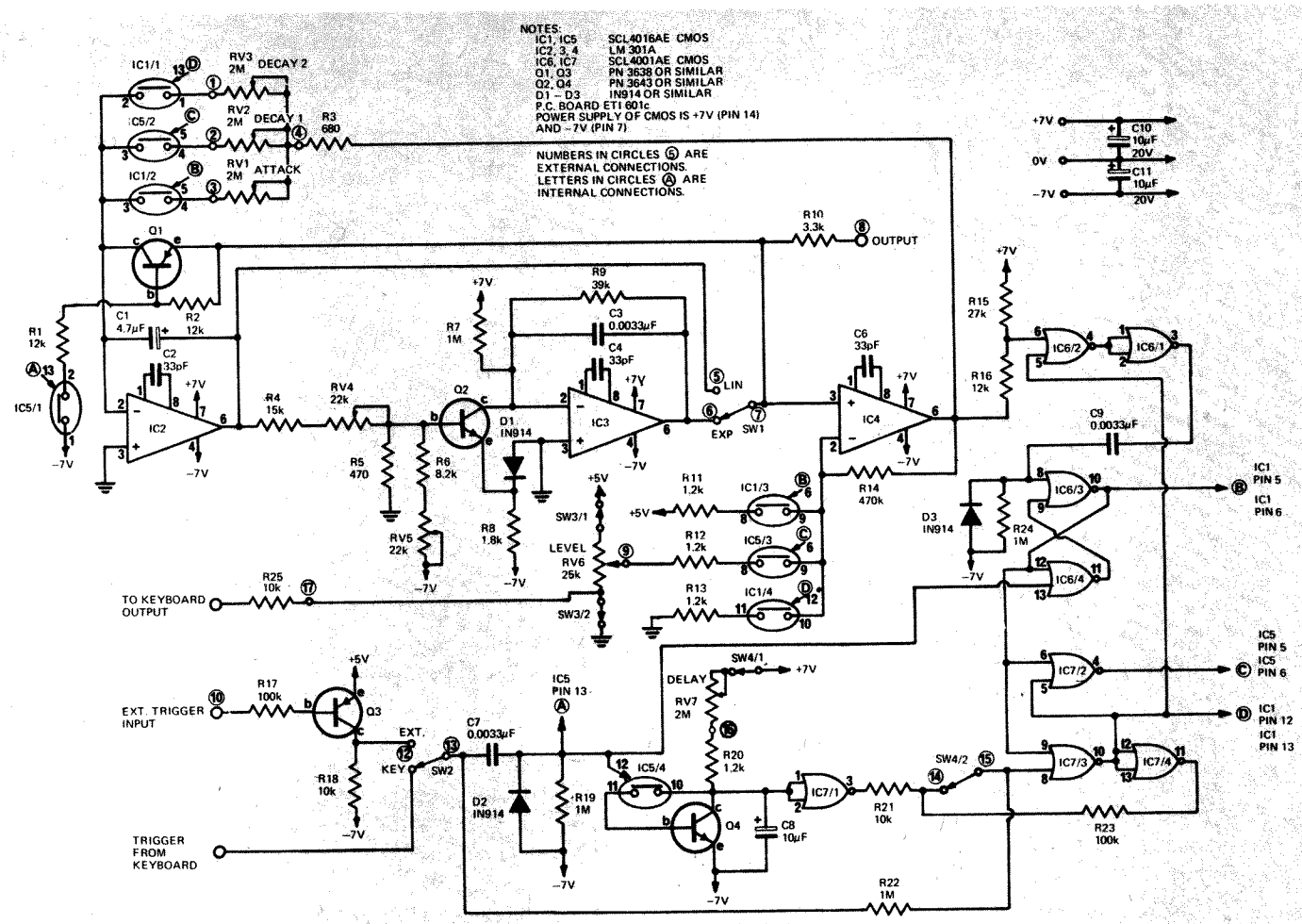


Fig. 1. Circuit diagram of Transient Generator 1. Envelope Control module also includes a modified VCA.

3600/4600 INTERNATIONAL MUSIC SYNTHESIZERS

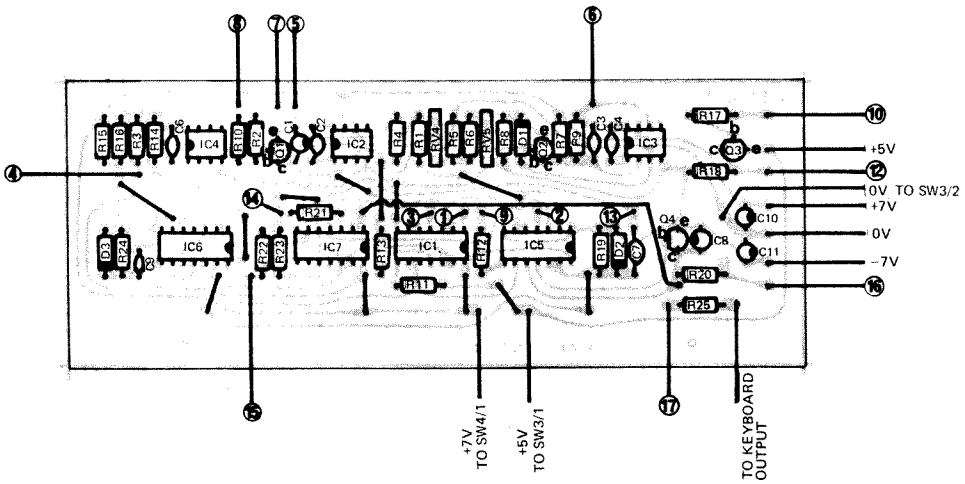


Fig. 2. Component overlay for Transient Generator 1.

This month's article commences the description of waveform shaping and control modules.

WE HAVE now described the main power supply, keyboard control and tone generator, and are now ready to build the circuitry used to shape the various generated waveforms as required.

It is advisable to re-read the first article in this series to gain a better appreciation of the purpose of the modules described this month.

CONSTRUCTION

Transient Generator I

Assemble components to the printed circuit board, as shown with the component overlay (Fig. 2), paying particular attention to the orientation of integrated circuits, transistors, diodes and electrolytic capacitors. We recommend that sockets be used for the CMOS ICs at least. These CMOS ICs should also be the last components to be fitted to the board.

The mechanical assembly is similar to that for the oscillators (previously described). All rotary potentiometers and switches are mounted on a bracket as shown in Fig.6. The bracket, in turn, is mounted onto the component side of the printed circuit board. The wiring between the potentiometer and the switches is as shown in Fig.8.

VOLTAGE CONTROLLED AMPLIFIER

This is a very simple module and should not cause any difficulty. The component overlay is given in Fig. 4. and the potentiometer and switch wiring diagram in Fig.9. The MC1496 may be either a dual-in-line package or TO5. If the TO5 version is used it may be connected as shown in Fig. 3. The tag on the T05 version is adjacent to pin 10 and this pin goes to what would otherwise be DIL pin 14 on the printed circuit board. Pin position 7, 9, 11 and 13 on the printed circuit board are not used with the T05 IC.

ENVELOPE CONTROL

The envelope control is constructed by assembling a transient 1 module and a voltage controlled amplifier (VCA) to the same bracket. The VCA module is modified by omitting the rectifier ICI (see 'How it Works' and overlay Fig.5) and the control input is taken from the transient 1 board output.

CALIBRATION

Transient Generator 1

The only section of this circuit that needs calibration is the exponential generator. The procedure is as follows:–

With the module switched to the linear mode check that normal output is obtained. Now with the trigger input disconnected, and the output voltage at 0V, adjust RV5 such that the output of IC3 is also 0V. Set *attack time* to minimum and *delay* and *hold level* to maximum. If the module is now triggered the output voltage will go to +5V and stay there for about 10 seconds.

Whilst the output is at +5V, adjust RV4 so that +5V is also obtained at the output of IC3. Recheck the 0V level and readjust if required. Repeat the procedure until both levels are correct.

When the module is returned to exponential mode check that the output of IC3 never goes negative.

Voltage Controlled Amplifier

The only adjustment required on this module is to null the output by adjusting RV1. With a signal applied to the input, and with 0V on the control input, set the switch to *amp* and adjust RV1 for minimum output.

PARTS LIST
Transient Generator 1

R1,R2,16, Resistor 12k ¼W 5%
R3 " 680 " "
R4 " 15k " "
R5 " 470 " "
R6 " 8.2k " "
R7,19,22,24 " 1 M " "
R8 " 1.8k " "
R9 " 39k " "
R10 " 3.3k " "
R11,12,13,20 " 1.2k " "
R14 " 470k " "
R15 " 27k " "
R17,23 " 100k " "
R18,21,25 " 10k " "
RV1,2,3 Potentiometer 2M log rotary
RV4,5 " 22k trim pot
RV6 " 25k lin rotary
DPDT switch (plain pot for envelope gen)
RV7 Potentiometer 2M log rotary
DPDT switch.
C1 Capacitor 4.7µF 25V tag
tantalum
C2,4,6 " 33pF ceramic
C3,7,9 " 0.0033µF polyester
C8,10,11 " 10µF 25V electrolytic
(pc mounting)
IC1,5 Integrated circuit SCL4016AE *
CMOS
IC2,3,4 " " LM301A
IC6,7 " " SCL4001 AE **
CMOS.
* The prefix and suffix of CMOS varies from manufacturer to manufacturer
** should be Solid State Scientific only (CEMA)
Q1,3, Transistor PN3638 or similar
Q2,4 Transistor PN3643 or similar
D1,2,3 Diode IN914 or similar
SW1,SW2, Switch SPDT miniature toggle C & K7201 or similar
SW3 Switch part of RV6 (not used on envelope generator)
SW4 Switch part of RV7
PC board ETI 601
Metal bracket to Fg.
Recommended extras
1 8 pin socket Utilux type M 2139-8
8 pins Utilux type M2138
4 14 pin IC sockets

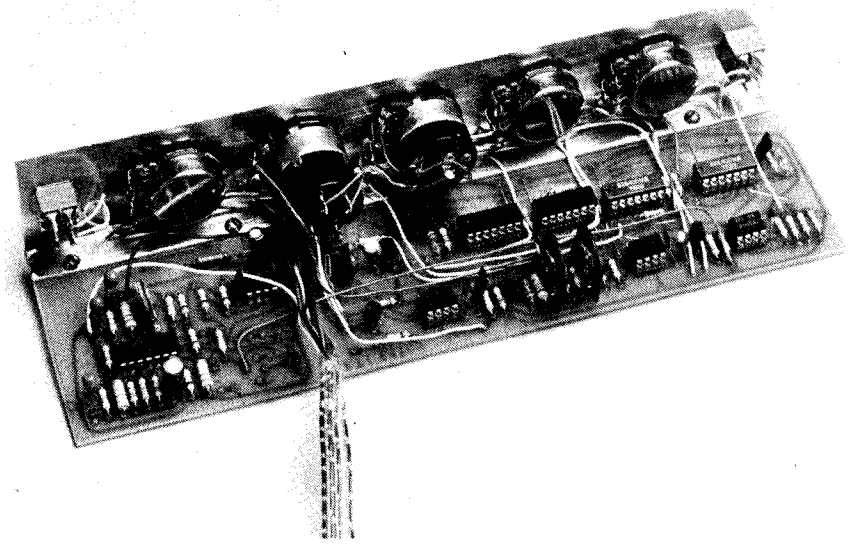
PARTS LIST
Envelope Control

All parts as for Transient Generator 1. Except that RV6 does not have a switch, delete R25.
All parts for Voltage Controlled Amplifier Except Delete
R3,R4,R5,R6,RV2,C3,C4,D1,IC1, metal work, socket and pins.
SW1.

PARTS LIST
Voltage Controlled Amplifier

R1 Resistor 8.2k ¼W 5%
R2,15,16 " 22k " "
R3 " 4.7k " "
R4,7,8,10 " 12k " "
R5 " 3.3M " "
R6 " 10k " "
R9 " 39k " "
R11,13 " 330 " "
R12 " 470k " "
R14,17,18,19,20 " 100k " "
R21 " 3.3k " "
RV1 Potentiometer 50k trim potentiometer
RV2 Potentiometer 10k lin rotary
C1 Capacitor 33µF 10V (tag tantalum)
C2,3,6 " 4.7µF 25V (tag tantalum)
C4,5 " 33pF Ceramic
C7,8 " 10µF 25V (electro pc mounting)
IC1,3 Integrated circuit LM301A MINI DIP
IC2 " " MC 1496 (or similar D.I.P. preferred)
D1 Diode IN914

SW1 toggle switch SPDT C&K 7201 (or similar)
PC board ETI 601
Metal bracket to Fig.
Recommended extras
1 8 pin socket Utilux type M2139-8
8 pin Utilux type M2138



The Envelope Control module, The Transient Generator 1 module is similar except that the VCA board on the left is not fitted.

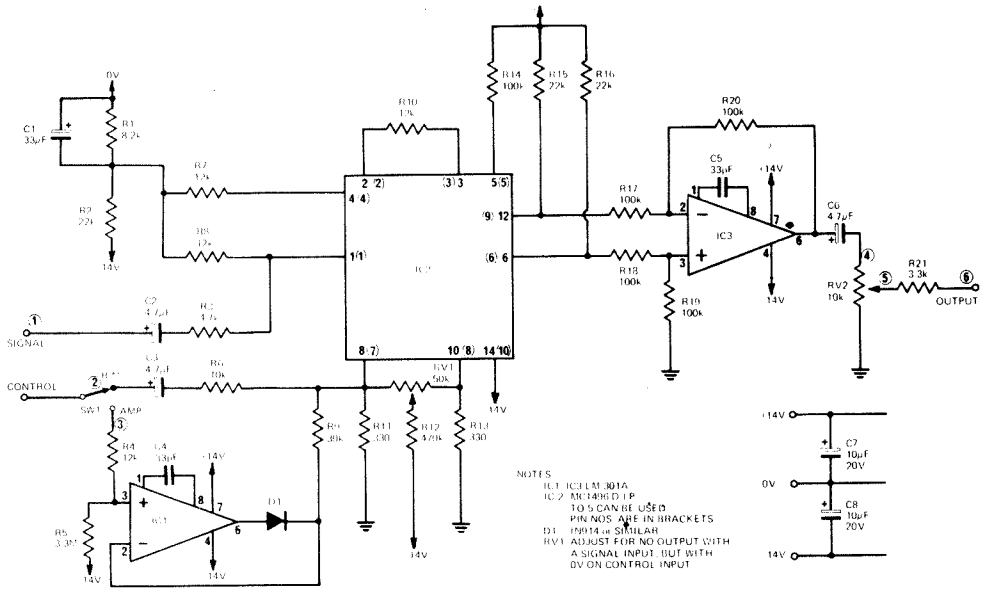


Fig. 3. Full circuit diagram of Voltage Controlled Amplifier. For use with Envelope Control module. IC1 and its associated components are omitted. See overlay, parts lists and text.

HOW IT WORKS
Envelope Control

This module is simply a combination of a Transient Generator Type 1 and a VCA, both of which have been described previously.

The only modification to the transient generator is the deletion of the hold-level switch and R25. (A hold level equal to the keyboard voltage is not required in envelope control).

The VCA is simplified by the omission of the rectifier (IC1) as the input is coupled directly from the output of the transient board and any zero error may be nulled out by the RV1. In addition the output potentiometer is not required and is therefore deleted.

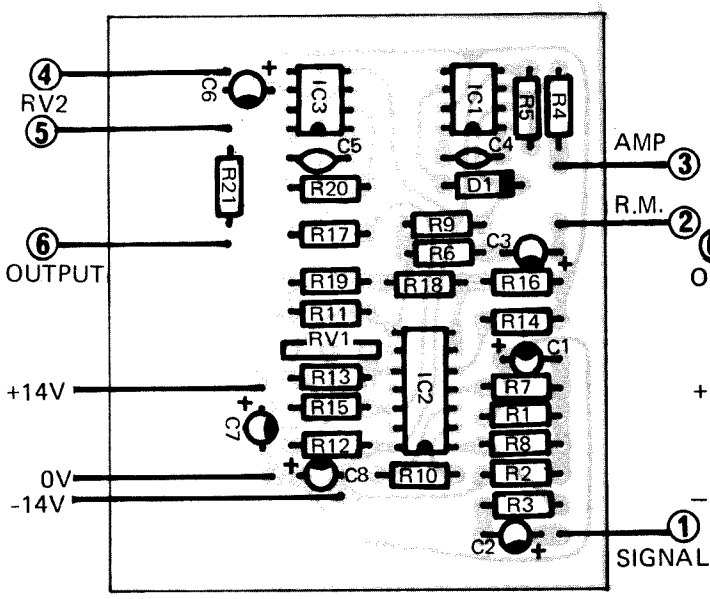


Fig. 4. Component overlay for the Voltage Controlled Amplifier when used as a separate unit.

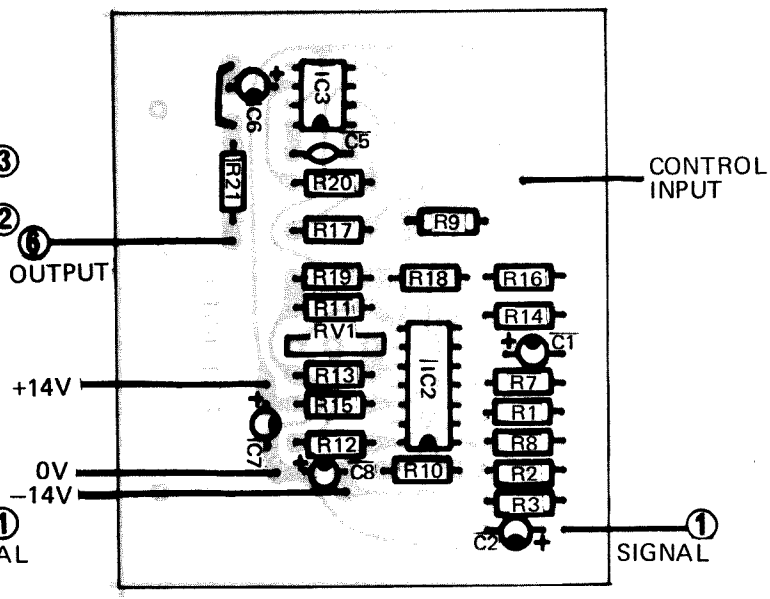


Fig. 5. Component overlay for the Voltage Controlled Amplifier as used in the Envelope Control module.

HOW IT WORKS
Voltage Controlled Amplifier

The voltage controlled amplifier is constructed around the MC1496 integrated circuit. This is a balanced modulator – demodulator, the internal circuitry of which is shown in Fig.10.

The 1496 has differential outputs, i.e. two outputs in antiphase, which are not referred accurately to the 0V line. A buffer amplifier (IC3) having differential inputs, is therefore used to provide a single ended output.

In fact the 1496 has two sets of differential inputs, one set biased at about 0V, and another set biased at approximately –3V.

The input signal is injected into one of the –3V biased inputs (pin 1) whereas the control signal is fed to the other input (pin 8).

When using the circuit as a VCA, the maximum possible attenuation is required when the input is 0V. However, due to tolerance variations, the 0V from other modules may be up to 20mV in error. Hence a rectifier, IC1, is used so that any voltage less than +50mV is regarded as 0V. The maximum attenuation at 0V control, is adjustable by RV1.

When the module is used as a ring modulator the control signal is ac coupled and the output will be the product of the two inputs.

HOW IT WORKS
Transient Generator I

The transient generator consists, basically, of two sections.
(a) the wave-shaping circuitry (analogue).
(b) Control circuitry (digital).

The analogue section consists of integrator (IC2), exponential converter (Q2, IC3) and comparator (IC4). The comparator is a high gain differential amplifier whose output is normally either at +6 volts or at −6 volts. There is a small input region where the amplifier operates in the linear mode and the output voltage will then be somewhere between these two extremes. Negative feedback is applied by R14 so that this linear input region is approximately 30 mV wide.

Solid state switches select one of three voltage sources as input to the comparator. ICI/3 selects +5 volts, ICI/4 selects 0V and IC5/3 selects the output of level potentiometer RV6 or the output of the keyboard.

The switch potentiometer RV6, when in the off position, allows the keyboard voltage to be the third voltage.

The output of the comparator is connected back to the input of IC2 by R3 and a slope potentiometer as selected by ICI/1, IC5/2 and ICI/2. If the output of the comparator goes to −6 volts, the output of the integrator, IC2, will be a voltage, linearly increasing at a rate set by the selected potentiometer (RV1, 2 or 3). Conversely if the comparator output is at +6 volts the integrator will produce a linearly decreasing voltage.

When the two inputs are within 30 mV of each other the slope of the integrator will decrease, and when they are equal, (comparator output at zero) the system output will be stationary at the voltage selected by ICI/3, IC5/3 or ICI/4. This point will be stable as the comparator output is applied back to its input in a negative feedback loop, either directly, or via an exponential generator.

Generation of the exponential function is based on the collector − current to base-emitter-voltage relationship of a transistor, in this case Q2. The output of the integrator, after attenuation by R4, RV4 and R5, and level shifting by R6 and RV6, is applied to the base of Q2. Diode D1 biases the emitter of Q2 about 0.6 volts below zero and also provides temperature compensation for Q2. Resistor R7 applies a small bias and helps compensate different offset voltages in IC3. Integrated circuit IC3 produces an output voltage proportional to the collector current of Q2. Hence a linearly changing voltage, at the output of integrator IC2, will result in an exponential output from IC3. The range of the exponential generator is adjusted by RV4 and RV5.

When a key is pressed, the keyboard controller provides a −7 V to +7 V change. The positive edge of this transistion is differentiated by C7 and R19, (the negative edge pulse is clipped by D2) to provide an approximately 3 msec wide pulse which turns on IC5/4 and Q4 thus discharging C8. In addition this pulse sets the flip flop formed by IC6/3 and IC6/4 so that the output at B is +7 V, and turns on IC5/1 and Q1 thus clamping the output line at 0V.

At the end of the 3 msec pulse, C8 begins to charge from −7 volts at a rate determined by RV7. When it reaches 0V, approximately, the output of IC7 changes from +7 V to −7 V and thus an internal delay is generated which is adjustable by RV7. Also immediately following the 3 msec period, he output B is at +7 V and hence ICI/2 is turned on selecting the attack potentiometer RV1, and ICI/3 is turned on, selecting +5 V as an input to the comparator. Thus, as pin 2 of the comparator is higher than pin 3, the output will be low (−6 V) and the integrator will start to rise. The voltage divider formed by R15 and R16 will apply −2 V to the input of IC6/2.

At this point we pause to briefly explain the operation of digital logic NOR gates. The digital ICs used in this circuit contain four, 2 input NOR gates. In a NOR gate, if either one or both of the inputs are high, the output will be low. Only when both inputs are low can the output be high. This is illustrated below.

Input A	Input B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Note for +7 V and −7 V supplies as used, 'O' means less than −1 V and '1' means greater than +1 V when applied to inputs, and 'O' means close to −7 V '1' means close to +7 V in the case of outputs.

Thus to return to our circuit the −2 V input at IC6/2 is a 'O' input and the output of IC6/2 will be high at +7 V.

When the output of the integrator (or exponential generator) reaches +5 V the comparator output will drop to zero volts causing an input of +2V to be applied to IC6/2. This is a '1' level and thus the output of IC6/2 will go to −7 volts. The output swing of IC6/2 is inverted by IC6/1 and differentiated by C9 and R24. The resulting positive pulse resets the flip flop (IC6/3 IC6/4) and the negative pulse is clipped by D3.

When the flip flop is reset its output goes to −7 V turning off ICI/2 and ICI/3 and a 'O' is presented to IC7/2 and IC7/3 (pins 6 & 9).

If at this time the delay period has not expired (that generated by C8 & RV7) a '1' will still exist at the output of IC7/1. Thus IC7/3 has a 'O' on pin 9 and '1' on pin 8 and its output will be a 'O'. Hence both inputs of IC7/2 are 'O' and its output will be a '1'. This turns on IC5/2 which selects DECAY 1 slope and IC5/3 which selects the output level set by RV6. The comparator now sees an error and drives the integrator to correct it. The output will stabilize again when the level set by RV6 has been reached. This output level will now be held until the "C" control is removed.

When the delay period is completed the pin 8 input to IC/3 goes to 'O', and since the other input is 'O', the output will be '1' and the output at 'C' will be turned off.

We now have the 'D' output at '1' and this selects the DECAY 2 potentiometer and 0V reference to the comparator. Again the integrator drives to correct the error. Positive feedback is provided around IC7/3 by IC7/4 so that the input may change much quicker.

When the delay potentiometer is switched off (SW4/1 and 2) trigger input will now be direct to IC7/3 pin 8 and the delay will be determined by the key-hold time only, and not by the internal generator.

If the DELAY time setting (either internal or external) is shorter than the time to complete DECAY 1, DECAY 2 will be initiated, provided the attack time is completed, immediately the delay expires.

If the DELAY setting is less than the ATTACK time setting the ATTACK will be completed, DECAY 1 eliminated and DECAY 2 initiated.

The trigger input from the patchboard is buffered by Q3 to ensure correct operating levels for the logic. It also provides an inversion which means that the trigger will occur on the negative edge of the input trigger pulse.

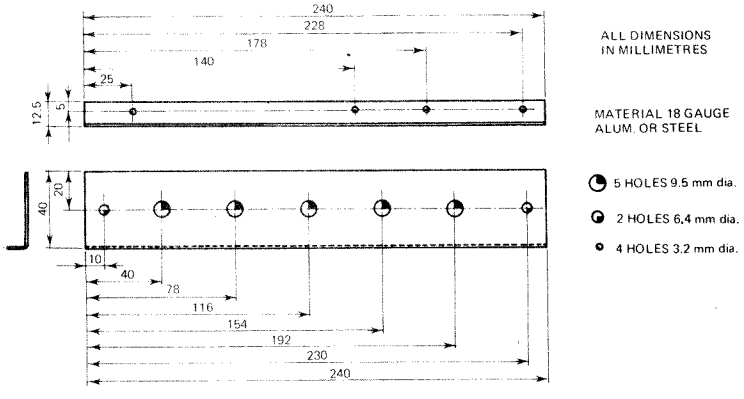


Fig. 6. Mounting bracket for Envelope control and Transient 1 modules.

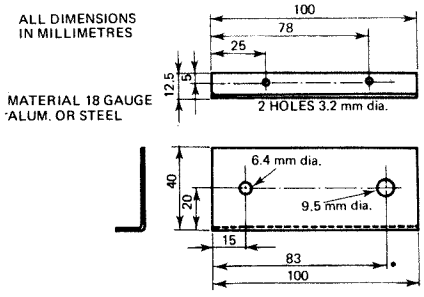
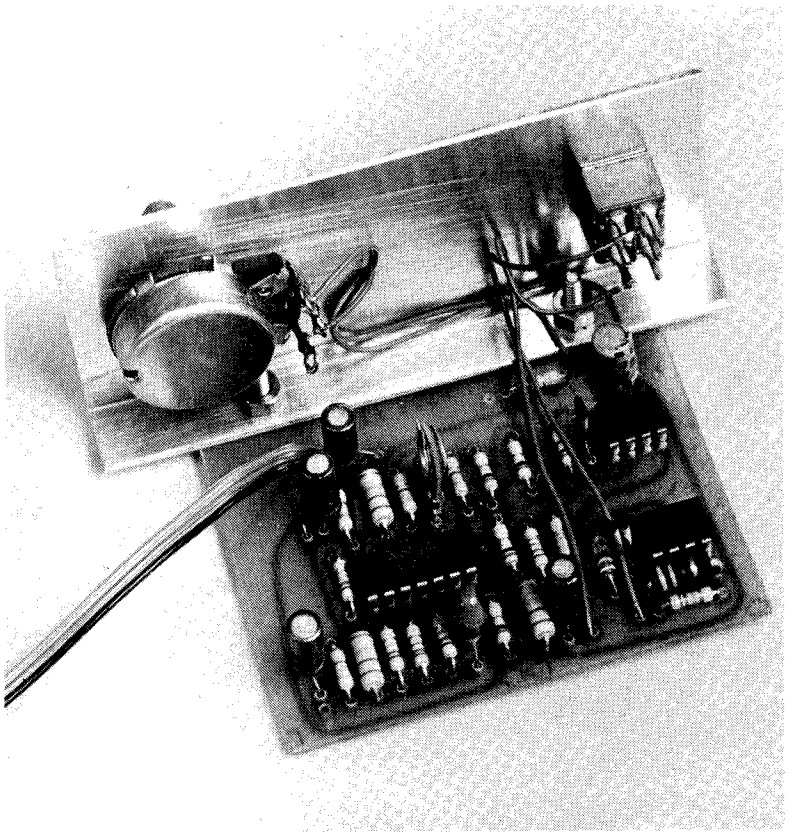


Fig. 7. Mounting bracket for the voltage controlled amplifier.



The voltage controlled amplifier

CORRECTION AND MODIFICATIONS

Power Supply Board

Current overload protection is provided on all power supply outputs. However, if an output power transistor having a current gain at the specified minimum of 30 (normal range 30-200) is used, excessive current will be drawn from the LM301A and it may possibly be damaged.

To obviate this the following changes have been made. Resistors R16, 17, 18 and 19 are all increased to 1 k. Cut the PC board track leading away from pin 6 of each of the LM301As and add a 470 ohm resistor across each break.

These precautions will limit the power in the LM301A to a safe level should a low current gain power transistor be obtained.

The overlay diagram, Fig. 2 page 75 of the December issue, has incorrect pin designations for Q7 and Q8. The emitter (e) and base (b) markings should be reversed.

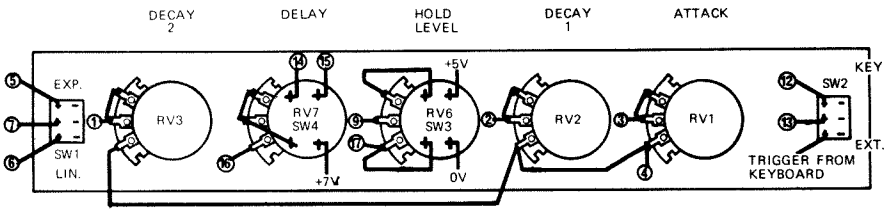


Fig. 8. Wiring to switches and potentiometer for Transient Generator 1.

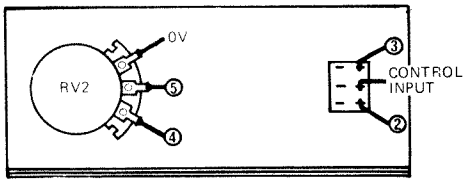


Fig. 9. Wiring to front panel of Voltage Controlled Amplifier.

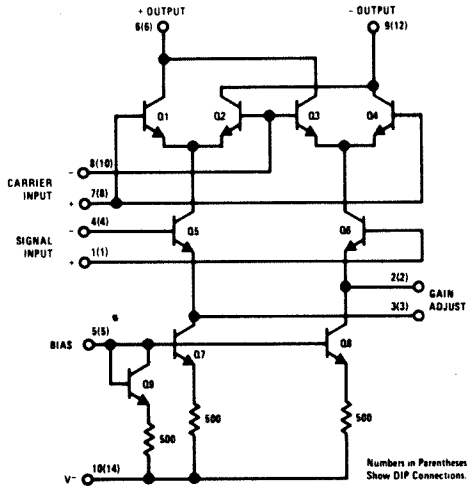


Fig. 10. Circuit diagram of the MC1496 balanced modulator – demodulator IC.