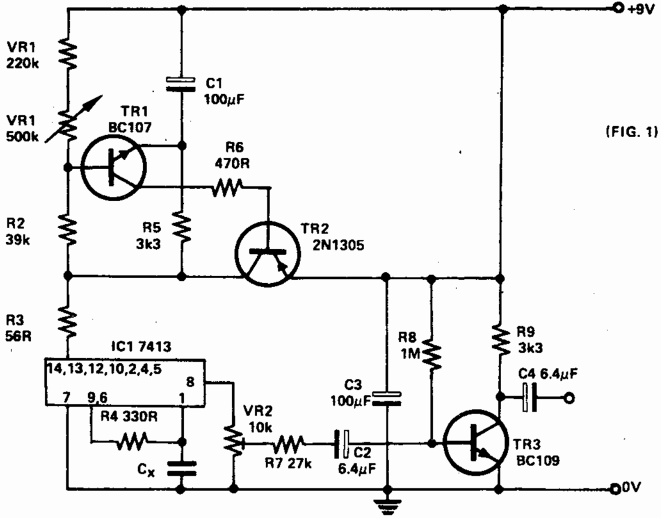
TONE BURST GENERATOR

The circuit in Fig. 1 generates the waveform shown in Fig. 2. The output is basically oscillations at a certain frequency outputed in small pulses. This type of waveform has varied uses ranging from a beat for an organ or synthesizer to audio or radio frequency testing.

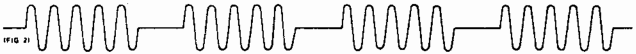
The variable parameters of the waveform are shown in Fig. 3:-

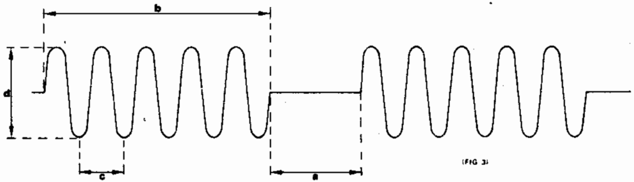
VR1 alters the time between pulses.
C1 alters the length of the pulse.
VR2 alters the amplitude of the waveform.
Cx alters the frequency of the waveform within a pulse. This ranges from .0005 giving RF, to 5 giving AF. (microfarads)



(FIG. 1)

(FIG 2)





(FIG 3)

Generating tone bursts with only two IC timers

by L. W. Herring
LWH Associates, Dallas, Texas

With very few external components, two IC timers can be made to function as a tone-burst generator that is useful for radio and telephone applications. In the circuit shown here, one timer controls the tone burst, and the other generates its frequency.

Normally, a tone-burst generator is built with three timers, two being required for the control function. Although a single timer in its delay mode could provide the initial time period, the second timer is required to generate the burst length and reset the first timer. Alternatively, in the astable mode, a single timer's output duty cycle could be adjusted for the quiet and burst periods, except for one thing—the time to the first burst would be almost twice as long as the time to subsequent bursts because the initial charging period of the timing capacitor is longer than later periods.

Nevertheless, a single timer can in a sense be fooled into providing the control function on its own if an RC network (resistor R_2 and capacitor C_2 in the figure) is added to the timer's ($TIMER_1$) threshold and trigger inputs. Of course, the larger primary timing network (resistor R_1 and capacitor C_1 in the figure) remains connected to the timer's discharge circuit.

$TIMER_1$ is set up as an astable oscillator. But its threshold inputs are kept high by the additional RC network (R_2 and C_2) for longer than it takes the timer's discharge circuit to completely discharge the main RC network (R_1 and C_1). This assures that the output period of $TIMER_1$ remains almost constant, no matter if the burst is the first one or the last one.

The period that $TIMER_1$'s output remains high can be approximated by the standard equation for delay-mode operation:

$$T_{on} = 1.1R_1(C_1+C_2)$$

The burst output time (when the output is low) can be adjusted to the desired value by the R_2C_2 network. This period is approximated by the equation for astable-mode operation:

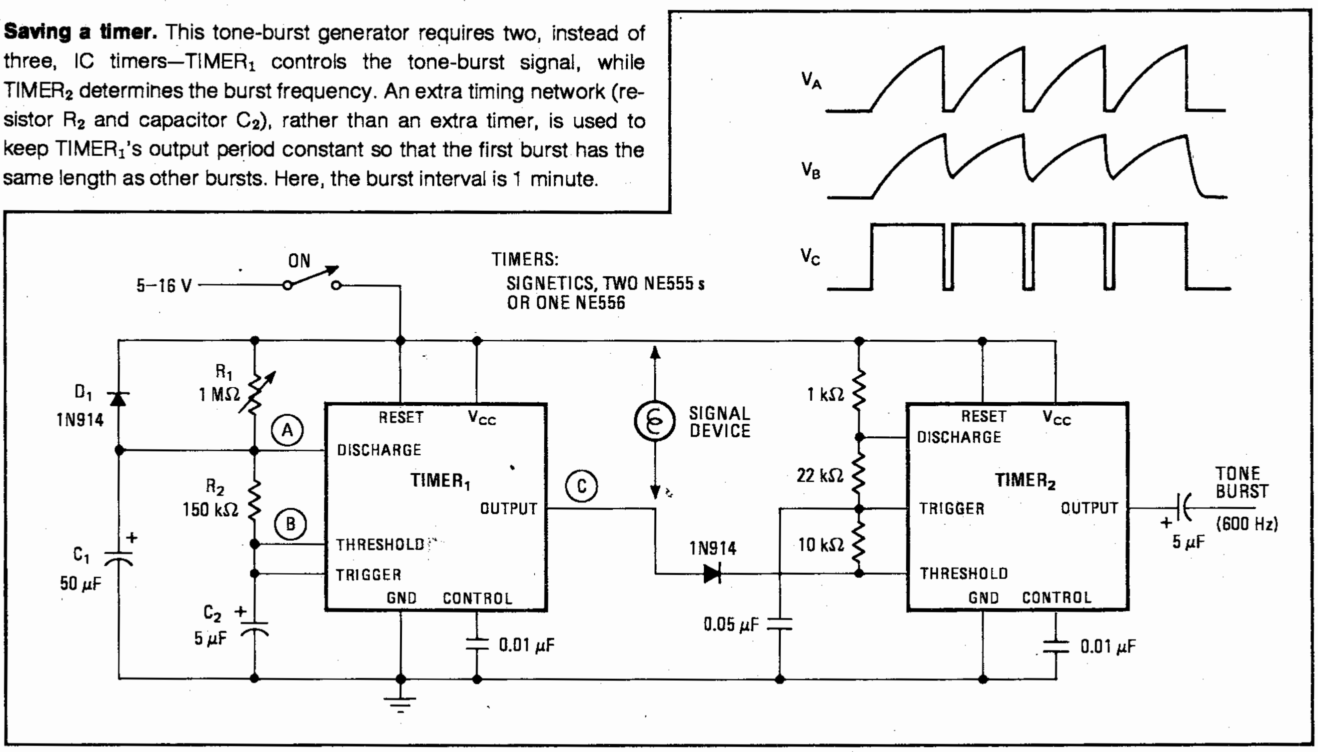
$$T_{off} = 0.693R_2C_2$$

When the added time period (burst length) approaches or exceeds the main time period, the two timing networks interact.

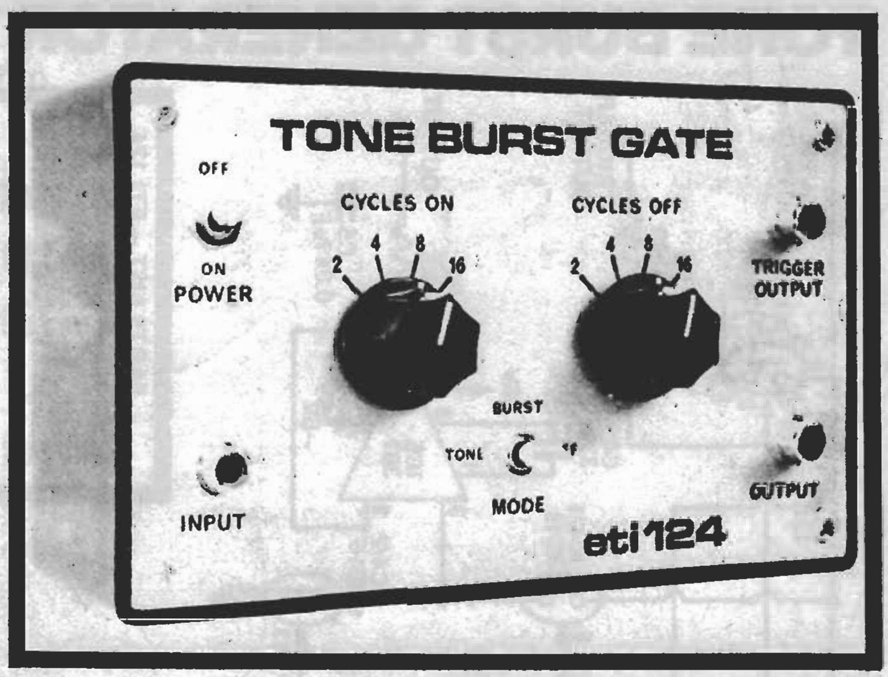
For this circuit, the output of $TIMER_1$ remains high for 1 minute and goes low for a half second. The best way to activate the circuit is to switch the V_{CC} supply lead for the entire circuit. Diode D_1 assures that capacitor C_1 will be discharged after any partial periods.

The control timer ($TIMER_1$) can provide the output for a lamp, bell, buzzer, or other signaling device. (This timer's output must be used to sink the signaling device, which must also be wired to the supply line.) $TIMER_2$ operates as the tone oscillator, determining the frequency of the tone burst. The manner in which $TIMER_2$ is keyed eliminates the need for an intermediate device to invert the output of $TIMER_1$ to operate the reset lead of $TIMER_2$.

This simple tone-burst generator can be used as an audible timing reminder for long-distance telephone calls or for radio repeaters that have 3-minute shutdown timers. The same arrangement can be used to generate sampling pulses for a sample-and-hold circuit or for a serial-to-parallel data converter for Ascii-character detectors. □



Saving a timer. This tone-burst generator requires two, instead of three, IC timers—$TIMER_1$ controls the tone-burst signal, while $TIMER_2$ determines the burst frequency. An extra timing network (resistor R_2 and capacitor C_2), rather than an extra timer, is used to keep $TIMER_1$'s output period constant so that the first burst has the same length as other bursts. Here, the burst interval is 1 minute.



eti project 124

TONE BURST GENERATOR

A valuable tool for testing loudspeakers.

TONE BURST testing is a technique which is rapidly gaining acceptance in a wide variety of applications. Typical applications are in testing of hydrophones, signal-to-noise in telephone channels, reverberation chamber testing and in the determination of peak distortion in loudspeakers. With loudspeakers, tone burst testing has the further advantage that the speakers may be tested with their maximum peak power level whilst keeping the average sound output level low enough to not annoy the neighbours — a considerable advantage indeed.

Some time ago our audio consultants, Louis Challis and Associates, asked us to build them a tone-burst generator and the resulting instrument has been used by them ever since with much success.

DESIGN FEATURES

A tone burst must always be an integral number of cycles. If the burst is switched on or off part way through a cycle then undesirable transients will be produced that will mask the test results. Thus the burst must start and end exactly at the zero-crossing point of the sine wave in the burst.

In the original unit, designed for Louis Challis, preset times can be independently selected for the on and off periods of the burst with the exception that the burst time is automatically modified to give an integral number of cycles. The preselected on/off ratio, however, is independant of the burst frequency. To give the required control range, six switched ranges as well as a variable control are provided for both the on and off periods. Other features of the original unit are the ability to start at any point in the cycle as well as the zero crossing point, a phase-inverting switch to select either the positive or the negative half cycle first and an OFF LEVEL control to set a base tone level which is modified when the tone burst occurs. In addition the dc level of the output can be set and a switch is provided to select burst, pure tone or off as required.

When it came to redesigning the unit as a project we decided that many of the features offered by the original design were unnecessary for the user concerned only with testing speakers. Hence the unit has been redesigned in a greatly simplified form.

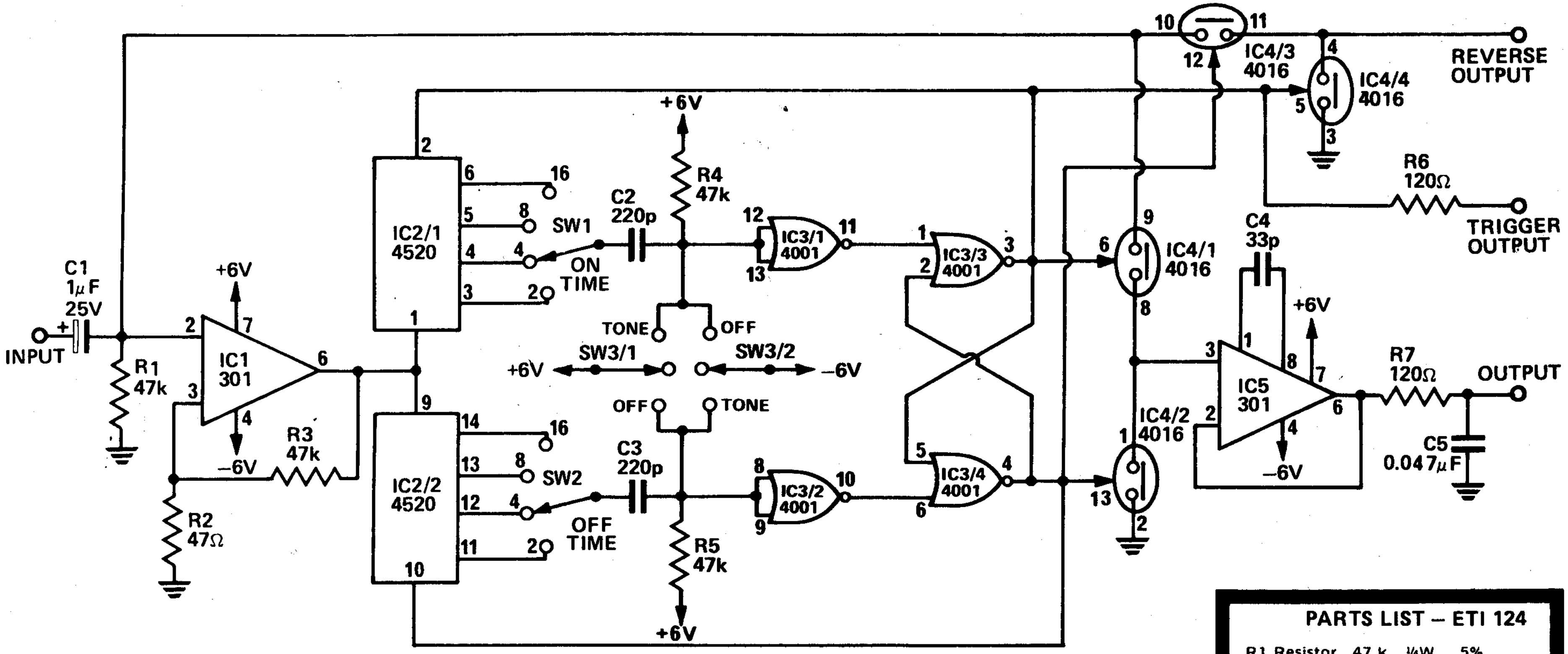
Instead of using monostables to generate variable on/off times we now divide the input with a counter to obtain times that remain in the same ratio regardless of input frequency. We settled for the ability to select 2, 4, 8 and 16 cycles for the duration of either period, as this compromise

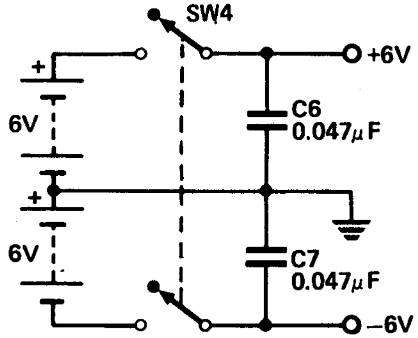
MEASURED PERFORMANCE

TONE BURST GENERATOR.

On Time Cycles.	2,4,8 or 16
Off Time Cycles	2,4,8 or 16
Frequency Response 3 Hz – 300 kHz	+0 –3 dB
Distortion 3 V input at 1 kHz	<0.02%
Input Level Maximum Nominal range	 3 V RMS 100 mV to 1 V
Input Impedance	47 k
Output Noise Voltage with no input	<25 μV
Power Supply Current	4 mA

TONE BURST GENERATOR





POWER RAILS OF IC2, IC3, AND IC4 NOT SHOWN
PIN 16 OF IC2 IS +6V
PIN 8 OF IC2 IS −6V
PIN 14 OF IC3 AND 4 IS +6V
PIN 7 OF IC3 AND 4 IS −6V
PIN 7 AND 15 OF IC2 ARE RESET PINS AND −6V

Fig. 1. Circuit diagram.

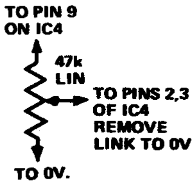


Fig. 4. How to add a potentiometer to the generator for burst-on-tone operation. That is the generator gives a continuous tone level with tone bursts of higher amplitude at intervals.

WHERE TO GET THE COMPONENTS

No problems should be experienced in obtaining the components assuming that you try a CMOS stockist for IC2,3,4. The 4520 is not widely advertised but is available from Sintel under the coding MC14520CP. The PCB will be available from either Ramar or Crofton.

PARTS LIST — ETI 124

R1	Resistor	47 k	¼W	5%
R2	"	47 Ω	¼W	5%
R3	"	47 k	¼W	5%
R4	"	47 k	¼W	5%
R5	"	47 k	¼W	5%
R6	"	120	¼W	5%
R7	"	120	¼W	5%
C1	Capacitor	1 μF 25V electrolytic		
C2	"	220 pF ceramic		
C3	"	220 pF ceramic		
C4	"	33 pF ceramic		
C5	"	0.047 μF polyester		
C6	"	0.047 μF polyester		
C7	"	0.047 μF polyester		
IC1	Integrated Circuit	LM 301A		
IC2	" "	4520 (CMOS)		
IC3	" "	4001 (CMOS)		
IC4	" "	4016 (CMOS)		
IC5	" "	LM301A		

SW1 Switch 1 pole 4 position rotary
SW2 Switch 1 pole 4 position rotary
SW3 Switch DPDT Toggle with centre off
SW4 Switch DPDT Toggle

PC Board ETI 124
8 1.5V 'AA' pencell batteries
2 4-way battery holders and clips
Plastic case
Escutcheon
3 single phono sockets
2 knobs

HOW IT WORKS – ETI 124

The input signal is squared by comparator IC1 such that the output of the comparator will be high if the input is above +6 mV, and low if the input signal is below −6 mV. Resistors R2 and R3 provide the necessary positive feedback to cause the IC to act as a comparator. The output of the comparator is connected to both clock lines of IC2. If the enable line is high these counters (IC2) will toggle at the input frequency.

IC3/3 and IC3/4 form an RS flip flop where the output must be in either a high or a low state, that is the flip flop has only two stable states. If the output of IC3/3 is high IC2/1 is allowed to clock and, after the number of input pulses selected by SW1 have been counted, the output from SW1 goes low. This low is coupled to the flip flop by C2 toggling the flip flop, disabling IC2/1 and enabling IC3/2. After the number of cycles, as selected by SW2, have been counted the flip flop is again toggled. IC3/1 and IC3/2 are used to square up the pulses generated by C2 and C3 respectively.

The input signal is also coupled to the output buffer, IC5, by the analogue switch IC4/1. When this switch is closed (control signal high) the output of the buffer will be the same as the input. When switch IC4/1 is open IC4/2 will be closed and the output will be held at zero. Since these switches are controlled by the flip flop the output will be the required tone burst.

A trigger output is taken from the flip flop to synchronize an oscilloscope if required. A second output is also available from pins 4/11 of IC4 which is the reverse of the main output.

Switch SW3 forces the flip flop into either of its two possible states thus allowing continuous tone or no output to be selected as required. In the centre position the normal tone burst is obtained.

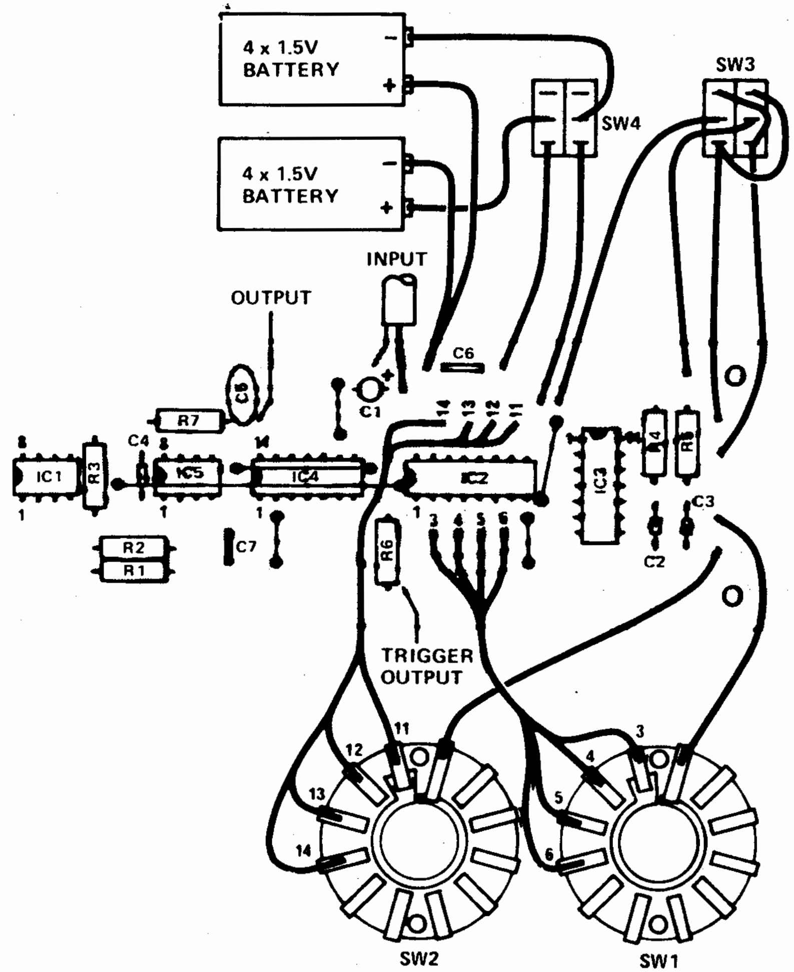
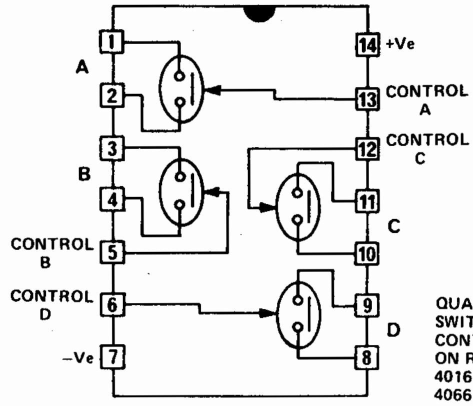
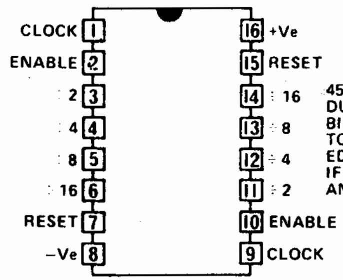


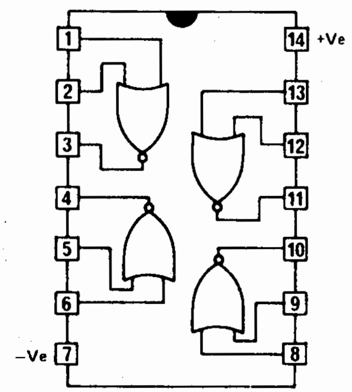
Fig. 2. Component overlay and interconnection diagram. Note that there are six links on the board, including two under IC4, which should be installed first.



4016
4066
QUAD ANALOGUE SWITCH. ON IF CONTROL IS HIGH
ON RESISTANCE
4016 TYP 280Ω
4066 TYP 80Ω



4520
DUAL 4 BIT
BINARY UP COUNTER
TOGGLE ON POSITIVE
EDGE OF CLOCK
IF ENABLE IS HIGH
AND RESET IS LOW.



4001
QUAD 2 INPUT
NOR GATE

INPUTS		OUTPUT
A	B	
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 3. Pin connections of the ICs used in the generator.

TONE BURST GENERATOR

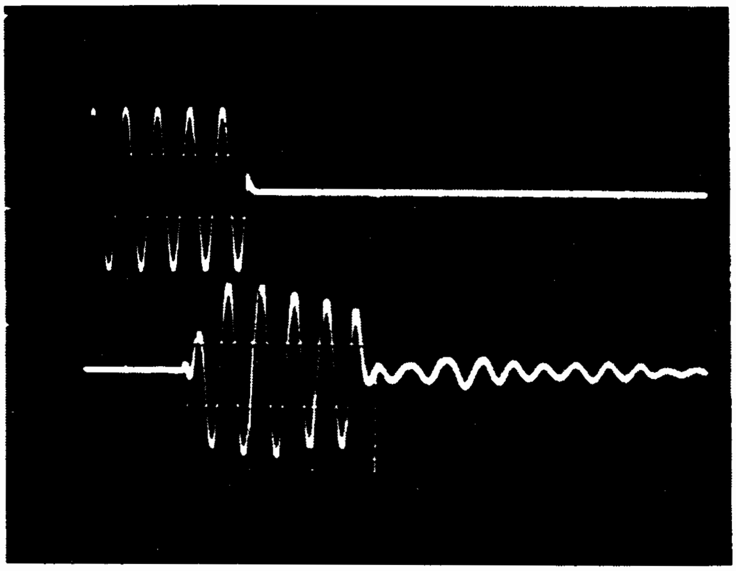


Fig.5 (a) Top trace — the input tone burst of five cycles. (original design).
(b) Bottom trace — the response of a low-cost speaker at 1 kHz. Note the reduced amplitude of the first half cycle and that ringing has added another cycle at the end of the burst. The room reflection can be seen on the trace after the burst.

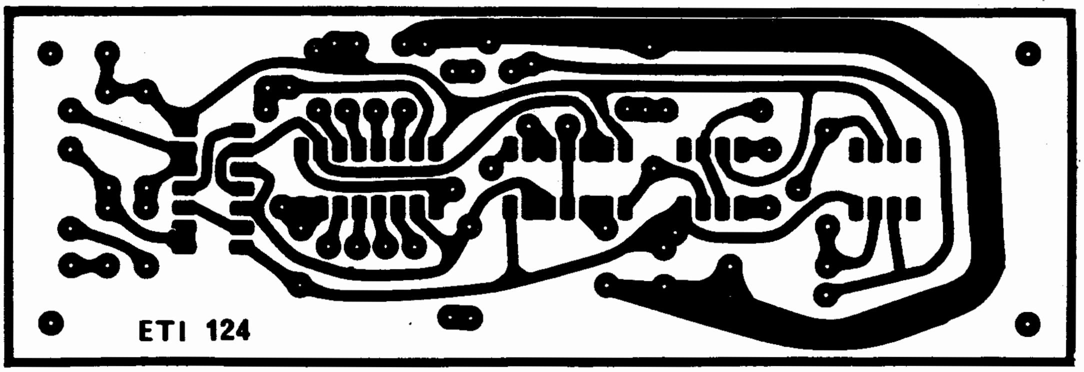


Fig.6. Printed circuit board for the Tone Burst Generator Full size. 142 x 47mm.

greatly simplifies the circuitry. We still have the switch to select tone, tone burst or off, but the OFF LEVEL control has been deleted. The latter control may quite easily be added, however, as shown in Fig. 4. . The output dc level control and the starting-point phase change have also been deleted.

Since we only need half of a CMOS 4016 IC, to give the required output, the other half may be used to give an inverse output if required, that is, the reverse output is on when the other is off and vice versa. This output is not buffered or brought out to the front panel. If it is intended to load this output with less than 47 k it is recommended that a 4066 IC be used instead which will handle loads down to 10 k. For loads of lower impedance than this, a buffer such as is on the normal output should be used.

CONSTRUCTION

As with any project construction is greatly simplified if a printed circuit board is used. However the layout of the unit is not critical and any other suitable method, such as Veroboard or Matrix board may be used if desired. We strongly recommend that sockets be used for the CMOS ICs, especially if a printed circuit board is not used, as these devices are quite easily damaged when soldering. The use of IC sockets also facilitates later servicing. Also remember that, unlike TTL, all unused inputs of CMOS must be connected to either the positive or negative supply rail.

The plastic box that we used measured 160 x 95 x 50 mm and is very convenient in that the printed circuit may be held in position by sliding it down behind two of the pillars to which the front panel is screwed. As the amount of lettering required is quite small, this may readily be done directly on the panel by hand or with Letraset.

Shielding of the internal wiring is not required providing that the unit is kept away from strong 50 Hz fields. If operation in the vicinity of strong fields cannot be avoided then the unit should be mounted in a diecast box.

USING THE UNIT

The testing of loudspeakers is very difficult indeed and much effort is still being spent to find test methods which will not only give an accurate understanding of the relative effectiveness of the design, but which will be easy to reproduce.

One of the main problems with speaker testing is that the speaker cannot easily be isolated from its environment. For example, reflections from the walls of a room modify the response, seen by a microphone, no matter where the microphone is placed in the room. If one could eliminate reflections then the situation would be improved considerably, and hence the use of anechoic (echo free) chambers for testing speakers. But such chambers are very expensive to build and consequently not readily accessible to the amateur.

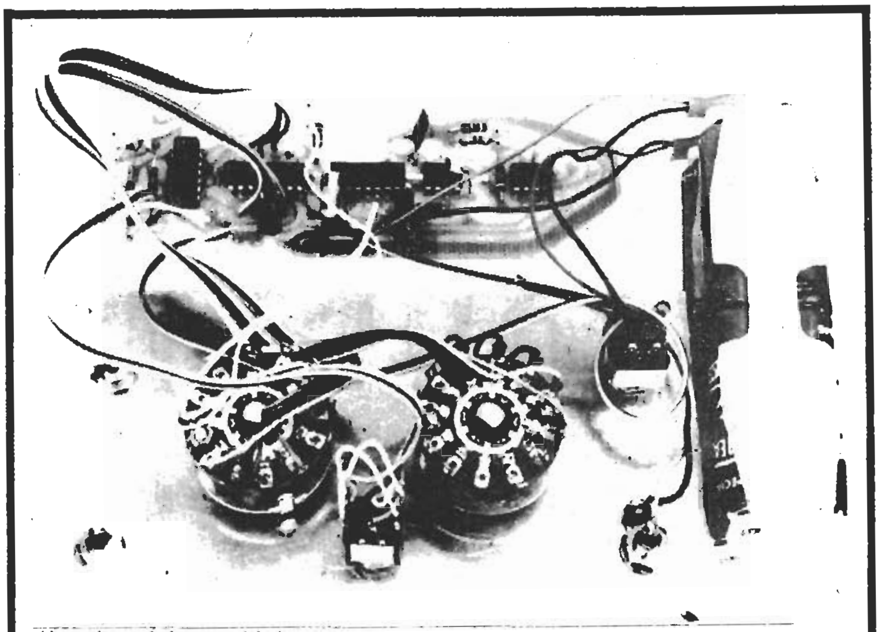
A further problem is in assessing the transient power handling capability of the speaker. Speakers will handle far greater peak transient power than is indicated by their RMS power rating. This is a very important attribute of loudspeakers in handling musical transients. Any attempt to assess this with a sinewave signal may result in the destruction of the speaker due to thermal failure — apart from also being extremely noisy.

The use of a tone-burst generator minimizes both these problems. How this is achieved is better understood by examination of Fig.5. This shows on the upper trace a five cycle 1000 Hz burst that is fed to a loudspeaker. The second trace shows the same burst as picked up by a microphone in front of the speaker. We notice that the burst has been changed by the speaker and an examination of these changes can tell us a lot about the speaker. For example we notice that the first half cycle has not reached full amplitude and this indicates that the speaker would have some difficulty in reproducing high frequency transients. Next we notice that instead of five cycles there are now at least five and a half. This could mean one of two things. Either there is a speaker/room resonance or, the speaker itself is continuing to vibrate after the original excitation has ceased. Which is it? We can determine this by changing the position of the speaker to see if any change occurs in the shape of the burst, if not it is caused by the speaker itself, and if it does then it is a speaker/room resonance. A speaker that lengthens the burst unduly will sound muddy in that region. Of course the speaker must be examined over its whole range to gain a thorough assessment of performance.

It is of course possible to eliminate room reflections simply by performing the tests outside. However unless one lives in a very quiet area, background noise will introduce problems — and your neighbours are unlikely to appreciate the noise that you will generate.

By varying the off period we can also select a ratio where the room reflection, the oscillation seen after the cessation of the burst, does not interfere with the first few cycles of the burst and the response versus frequency of the speaker may then be assessed from the amplitude of the first half cycles that are stable in amplitude. Thus it is possible to gain an appreciation of the frequency response, transient performance and quality in terms of ringing of a speaker by careful use of the tone-burst technique.

The transient power handling capability of a speaker may be assessed by selecting a fairly long off to on ratio for the burst and by feeding the burst to the speaker via a high-power amplifier. If for example an off to on ratio of 8:1 is used then the peak power will be eight times the average power. Thus the speaker may safely be driven to a peak level where a predetermined amount of distortion occurs. Take care that the amplifier is capable of providing the peak power required.



How the unit is assembled.

Of course a tone-burst generator may be used for a wide range of testing. We have mainly concentrated in this article on its application to the testing of loudspeakers.

The circuitry of the tone-burst generator may easily be modified for use as a 'silent switch' for A/B speaker testing. The method of doing this will be described next month. ●

ETI HELPING HAND COMPETITION

The Silver Trophy specially designed for the winners of Helping Hand

THE PROBLEMS

1 A sick person is being looked after by a deaf person. The deaf person has no useful hearing and requires to know whether the sick person is all right and above all needs to know if the sick person is in a state of distress anywhere in the sick room.

2 A hard of hearing person is attending a College of Further Education and has considerable difficulty in understanding what the lecturer says due to his distance from the lecturer and to the background noise in the room. A device is required to enable him to make the best possible use of his hearing.

3 Many deaf people have great difficulty in using the telephone and in fact many of them cannot use the telephone at all. The development of a writing tablet which would allow them to write a message on a small pad and for this to be communicated over the telephone line to a pad at the other end would have many great advantages. In addition the communication should be two way so that the person can receive a message or an indication that the message has been received.

This is our open competition to find solutions for problems facing the deaf.

This closing date is March 31st 1976. ETI and the Royal National Institute for the Deaf (RNID) are co-operating fully in the organisation of this competition.

Three problems are shown above. We invite individual readers, clubs, schools, universities, companies, in fact anybody, to develop a practical solution. The rules are as basic as possible and impose virtually no restriction apart from insisting that any Patent Royalties are waived if the idea is produced.

The prizes, three in all, will each be a silver trophy specially designed for ETI. At the close of the competition the magazine will hand over £250 to the RNID to help with development costs. There is a £1.00 entry fee (payable to RNID) and this will be added to the £250.

Background information has been prepared to help readers and say what is alreayd known. This is available from ETI on receipt of a large self-addressed envelope. Enquiries should be sent to:

Helping Hand,
ETI Magazine,
36 Ebury Street,
London, SW1W 0LW.

Fast-starting gated oscillator yields clean tone burst

by Walter C. Marshall
National Oceanic and Atmospheric Administration, Seattle, Wash.

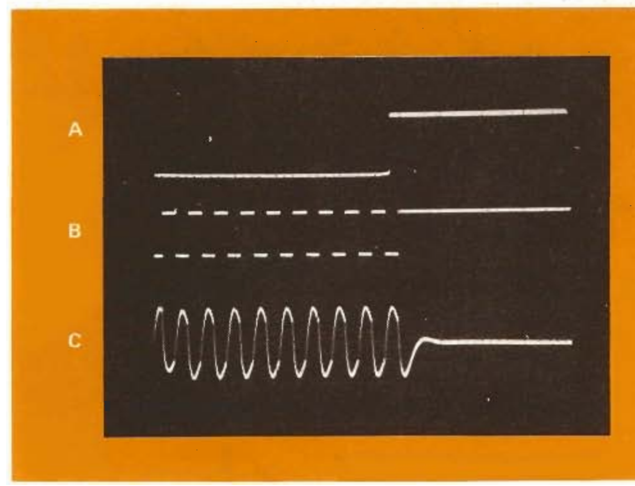
Synchronization pulses required for analyzing recorded data are usually frequency-multiplexed on one channel of a laboratory-type tape recorder. To ensure a high degree of accuracy in the data analysis, the gated tones must exhibit precise start-up and high monotonicity. This gated oscillator, which turns on with the leading edge of the gate pulse, always passes an integral number of cycles. And because the last cycle is never truncated, the oscillator produces no higher-frequency harmonics that could interfere with other decoders.

The complete gated oscillator, shown in Fig. 1, is built with only one complementary-metal-oxide-semiconductor integrated circuit, a 4011 quad two-input NAND gate. Two of the gates, labeled B and C, form the RC square-wave oscillator, which has a frequency that can be adjusted from about 4 to 25 kilohertz by varying the 10-kilohm potentiometer. The remaining two NANDs perform the discrete gating function.

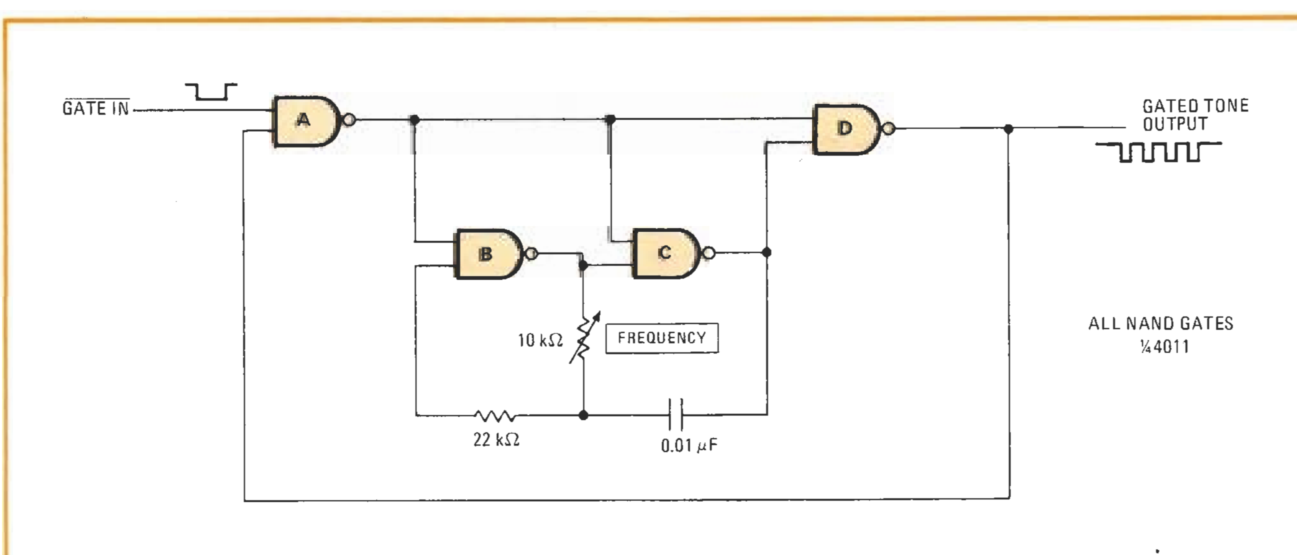
A logic 0 at the input to NAND gate A enables the three other NANDs, and thus the signal at the output of NAND D begins its voltage transition concurrently with the leading edge of the gating pulse. Truncation of the last cycle of the output signal is prevented by returning the signal to input NAND A. If the gating pulse should cease (go high) when the output of D is at a low level, the output of NAND A is unchanged, and the oscillator continues until a cycle is completed. Once the output of NAND D returns high at the end of a cycle, gate A turns off and the tone burst is cleanly terminated.

An oscilloscope photograph of the signals is shown in Fig. 2. Waveform A is the gating pulse, and B is the gated output. At the cessation of the gating pulse (positive transition), the oscillation of the output signal continues until the cycle is completed.

Waveform C is the gated output after it has been passed through a two-pole active bandpass filter to remove higher-frequency components. This tone is then mixed with other synchronization tones and applied to the tape-recorder input. □



2. No truncation. Scope photo shows trailing edge of synchronizing signals. Waveform A is the closing of the gating pulse (positive transition), and B shows completion of last cycle in gated tone output, despite closing of gate. Waveform C is the filtered burst, stripped of higher-frequency components for recording.



1. Clean tone burst. One-chip circuit generates tone burst of an integral number of cycles when gated by a negative-going input signal. Basic RC square-wave oscillator built around NAND gates B and C is adapted from RCA applications note ICAN-6267.

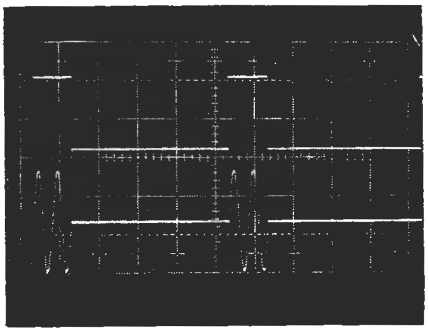


Fig. 2

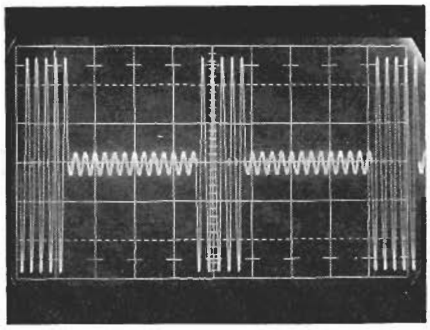


Fig. 4-a

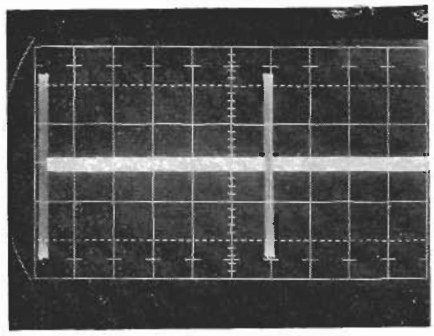


Fig. 4-b

FIG. 2—TONE BURST AND SYNC PULSES, lower and upper traces, respectively. The leading (positive-going) edge of sync pulse is usually used to sync scope.

FIG. 4-a—TONE BURST switched between two levels without reaching zero. (b)—TEST SIGNAL for an audio compressor. (c)—COMPRESSOR OUTPUT when fed with a tone burst like that in Fig. 4-b.

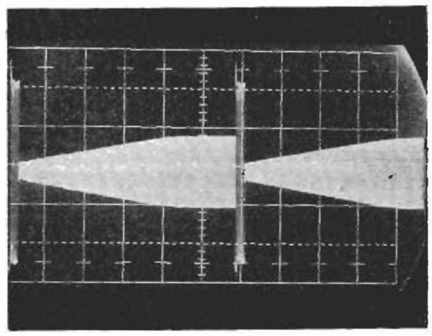


Fig. 4-c

14 Ways To Use R-E's Tone-Burst Generator

Here's a new way to test all kinds of electronic equipment with a new kind of test instrument

by TOM ANNES

TESTING WITH TONE BURSTS IS A TECHNIQUE that is starting to come into use. This technique consists of subjecting a piece of equipment to an ac transient or tone burst and observing the results on an oscilloscope.

There are two basic methods of generating tone bursts. The first method is to use a voltage-controlled oscillator. Turning the control voltage on and off causes the oscillator to turn on and off to create a tone burst. This technique is used to give tone burst capability to some models of commercially available function generators.

The second method is to use a gate to control the output of existing oscillators and waveform generators. This technique was chosen for a future construction article in this magazine. The reasons for this choice are: (1) it can be used to gate any type of waveform generator that you may have on hand, even a noise generator; and (2) it is a more versatile unit yet lower in cost.

Controls and their uses

Let us now learn the controls and their uses. Fig. 1 shows the front panel of the instrument we built last month. (**Radio-Electronics,** July 1971, page 22.) The center knob selects the voltage level on the input waveform where gate opening and closing takes place. It also serves as the power switch. Below this is the TRIGGER SLOPE switch. This little slide switch selects which slope (positive or negative going) is used for gate switching. The two knobs on the right control the period between the start of successive bursts. The one on the far right is the vernier. The bar knob selects the range. This control also has a SINGLE-BURST position. In this mode of operation, the generator produces only one burst and then stays off until reset. Resetting is done by applying a ground or a positive pulse to a BNC jack on the rear panel.

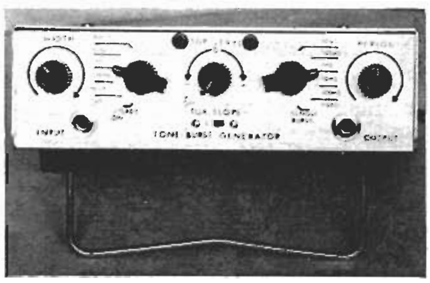


FIG. 1—TONE-BURST GENERATOR you studied and built last month. Now, you are ready to try its multitude of uses.

The two controls on the left control burst width. They are set in the same manner as the period control. The STEADY ON position overrides all other controls and close circuits (closes) the gate. If the PERIOD switch is set to SINGLE BURST, the output will be turned off if the WIDTH switch is in any position other than STEADY ON. This gives good on-off control for setting levels.

The status of the gate is indicated by the red and green traffic lights on the front panel. In actual operation, the intensity of these lamps give an indication of the time on, time off ratio of the gate.

Figure 2 shows the time relationship of the sync pulse and the tone burst.This pulse is available at the back panel for oscilloscope triggering. Setting the oscilloscope to trigger on the positive slope will start the sweep at the start of the tone burst.

The other controls on the rear panel are an INTERNAL-EXTERNAL SYNC selector switch, a SYNC INPUT jack, and a PEDESTAL NULL control. This PEDESTAL NULL control is used to balance out any change of dc output voltage between gate open and gate closed condition.

1. Compression amplifiers

Compression amplifiers, also known as regulated-output amplifiers, have several characteristics that are very easily checked with tone bursts. They are:

1. **Attack Time:** The time required for the compression circuits to take hold and reduce the gain.

2. **Overshoot:** The amount the amplifier output momentarily exceeds the reference or regulation level.

3. **Settling Time:** The time required for the output to stabilize after the amplifier is subjected to signal that exceeds the regulation level by some specified amount.

4. **Recovery Time:** The time required for the amplifier gain to recover after removal of a signal that exceeds the regulation level by some specified amount.