TECHNICAL DATA

SN76488N COMPLEX SOUND GENERATOR

The SN76488N Complex Sound Generator is an Integrated Circuit combining both analog (linear) and digital (I^2L) circuitry. It generates special-effect noises, tones and low-frequency based sounds. You can create a wide variety of sounds using various external components, and by controlling the input logic. Sample application circuits are included with this sheet. The SN76488N can be used in any application requiring audio feedback to the user, such as — home video games, pinball, alarms, toys, etc. or industrial equipment (indicators, feedback controls, etc.).

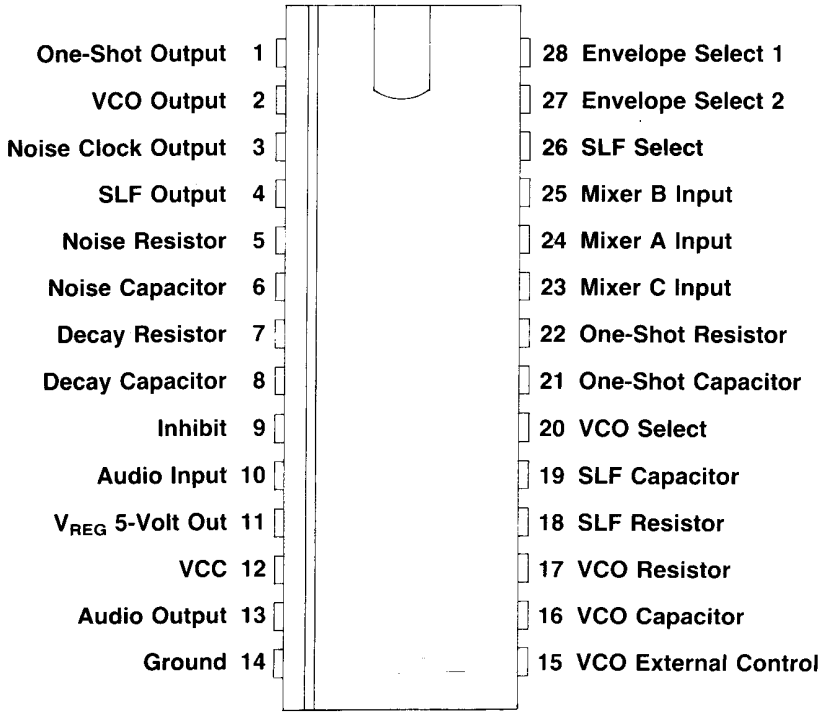
FEATURES

- Built-in 125 mW Audio Amplifier
- Allows Custom Sounds to be Easily Created
- Built-in Voltage Regulator
- Low Power Requirements

Operating Conditions:

Supply Voltage (Pin 12) . 9-volt (with Regulator 7.5 MIN-10.5 MAX)
Output Voltage 5-volts
Amplifier Load . . . . . 8 Ohms
Operating Temperature Range. . . . . .0°C - 70°C
NOTE: All voltage values are with respect to ground terminal (Pin 14).

N PACKAGE
(TOP VIEW)



HANDLING INSTRUCTIONS:

Do not exceed recommended maximum ratings given for this chip.

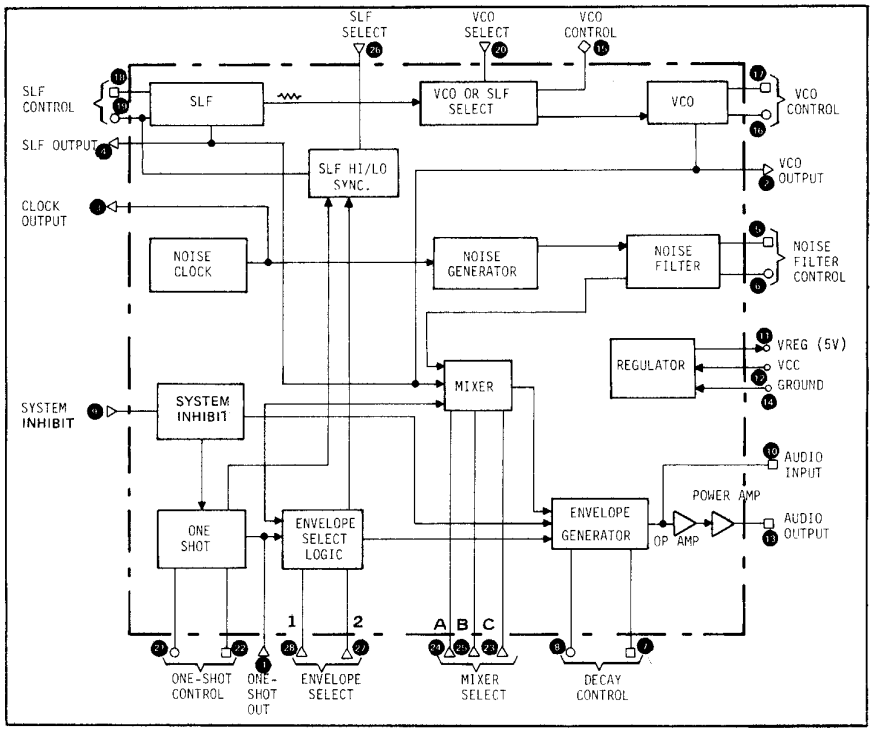
Do not connect any control resistor or control capacitor pins to V_{CC} (Pin 12).

Logic Pins left open are normally low.

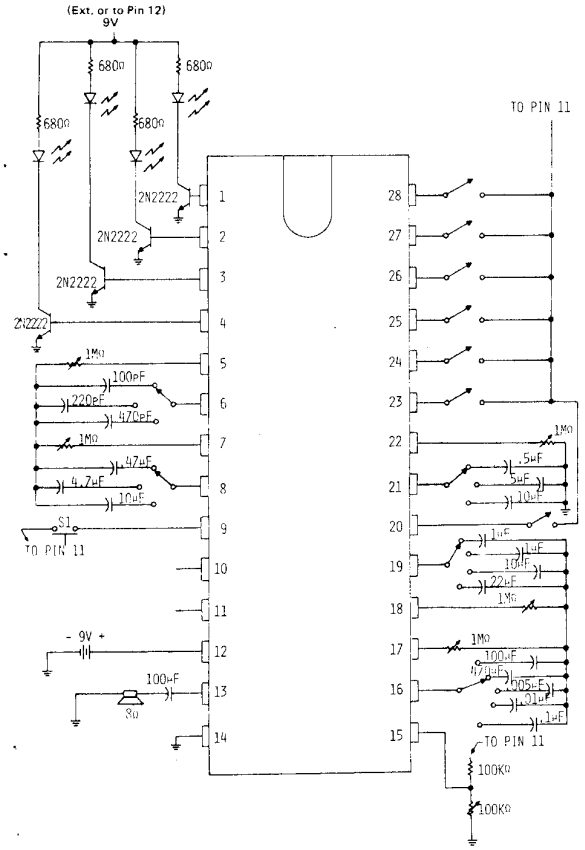
(If you are using more than one SN76488N chip, you may notice a difference in the sounds they produce.)

BLOCK DIAGRAM

- ▷ DENOTES OUTPUT
- ○ DENOTES PROGRAMMING VIA CAPACITOR
- □ DENOTES PROGRAMMING VIA RESISTOR
- ◁ DENOTES PROGRAMMING VIA LOGIC LEVEL
- ◇ DENOTES PROGRAMMING VIA ANALOG VOLTAGE



SN76488N DEMO/TEST BOX



Here's a handy way to create your own complex sounds. You can build a demonstrator test box as shown in the schematic. This demo test box will let you quickly change the values of resistors and capacitors to produce various sounds.

NOTE: A Volume Control (0 - 5KΩ MAX) can be added between the Audio Input (Pin 10) and the Audio Output (Pin 13).

Keep a log of the sounds produced by different arrangements of the test box components. We've included an entry for a gunshot sound as an example.

	GUNSHOT			
RESISTORS				
Decay	470K			
Attack	4.7K			
Amplitude	150K			
One-Shot	330K			
VCO	—			
Filter	82K			
SLF	—			
Pitch	—			
VCO Ext	—			
LOGIC CONTROL				
Env 1	H			
Env 2	L			
Mixer A	L			
Mixer B	H			
Mixer C	L			
VCO Select	—			
CAPACITORS				
One-Shot	.01			
SLF				
VCO				
Filter	470p			
Attack/				
Decay	.68			

Complex Sound Log

H = high logic level L = low logic level or open

OPERATION

REGULATOR

The internal 5-volt regulator makes it possible to apply a 7.5-volt **minimum** to 10.5-volt **maximum** unregulated supply to Pin 12. The circuit will therefore operate from a single supply (such as a 9-volt battery). The regulator will also supply up to 5 mA from Vreg (Pin 11) to drive one TTL load.

SLF (SUPER LOW FREQUENCY OSCILLATOR)

The SLF is normally operated in the range of 0.1 - 30 Hz, but will operate up to 20 kHz. The frequency is determined by the SLF control resistor (Pin 18) and the SLF control capacitor (Pin 19), according to the following equation:

$$\text{SLF Frequency a (Hz) 5V} = \frac{0.66}{(9K\Omega + R_{slf}) \times C_{slf}}$$

The SLF feeds a 50% duty cycle square wave to the "mixer"; it also feeds a triangular wave to the External VCO or SLF Select.

VCO (VOLTAGE CONTROLLED OSCILLATOR)

The voltage controlling this oscillator may be the SLF output, as mentioned above, or it may be an externally applied signal. The selection of control is made by the VCO Select (Pin 20). When a high logic level (above 2.35V) is applied to the VCO Select, the VCO output frequency is controlled internally by the SLF. (The higher the voltage applied, the lower the VCO output frequency.) The VCO output frequency controlled by the SLF is a frequency-modulated tone. When a low logic level (–2.35V) is applied to Pin 20, the VCO output frequency is controlled by an external signal (or voltage) that may be applied on Pin 15. This external input may be a DC voltage (it will produce a constant tone at the VCO output), or an input that will modulate the VCO output frequency.

NOTE: An external 0 - 2.35V voltage applied to Pin 15 will produce a varying tone. Above 2.35V will not be an audible sound.

Another way of applying an external voltage to the VCO input is to place the controlling voltage on the SLF control capacitor (Pin 19). (In some applications this may be more convenient than using the Pin 15 input.)

The frequency range of the VCO is internally set at an approximate ratio of 10:1, so the maximum frequency of the VCO will be 10X the minimum frequency. The minimum frequency is determined by the VCO control resistor (Pin 17) and the VCO control capacitor (Pin 16), according to this equation:

$$\text{Minimum VCO Frequency @ 5.0V (Hz)} = \frac{0.6}{(9K\Omega + R_{vco}) \times C_{vco}}$$

The output of the VCO is a square-wave pulse supplied both to the mixer, and through the envelope-select logic to the envelope generator and modulator.

NOISE CLOCK

The Noise Clock feeds timed pulses to the Noise Generator. The Noise Clock's minimum frequency is 10 kHz. (This signal is also present at the clock output [Pin 3], and can be used for multiplexing signals.)

NOISE GENERATOR/FILTER

The Noise Generator produces a psuedo-random white-noise that passes through the Noise Filter before entering the mixer. The Noise Filter is a variable bandwidth low-pass filter with a cut-off point controlled by the Noise Filter (NF) Control Resistor (R_{NF}) Pin 5 and the NF Control Capacitor (C_{NF}) Pin 6, according to this equation:

$$\text{Noise Filter Cut-Off @ 5.0V (Hz)} = \frac{.43}{(9K\Omega + R_{NF}) \times C_{NF}}$$

MIXER

The Mixer logic selects one, or a combination, of the inputs from the generators (VCO, SLF, NOISE) and feeds the output to the Envelope Generator and Modulator according to the following table:

Mixer Select Inputs			Mixer
C (Pin 23)	B (Pin 25)	A (Pin 24)	Output
L	L	L	VCO
H	L	L	SLF
L	H	L	NOISE
H	H	L	VCO/NOISE
L	L	H	SLF/NOISE
H	L	H	SLF/VCO/NOISE
L	H	H	SLF/VCO
H	H	H	INHIBIT

SYSTEM INHIBIT LOGIC

The System Inhibit Logic provides an inhibit/select control for the system output. The sound output is controlled by the logic level on Pin 9. A high logic level inhibits the sound. A low logic level input allows the sound. The System Inhibit input also triggers the "one-shot" logic.

ONE-SHOT LOGIC

The "one-shot" logic controls momentary sounds such as gunshots or explosions. It is accomplished by a high-to-low logic transition on Pin 9. The maximum duration of the "one-shot" is about 10 seconds and is controlled by the "One-Shot" Resistor (R_{OS}) Pin 22 and the "One-Shot" Capacitor (C_{OS}) Pin 21. The duration can be figured:

"One-Shot" Duration @ 5.0V (seconds) = .91 (R_{OS} + 9KΩ) X C_{OS}

When the "one-shot" is controlled by external logic, the R_{OS} and C_{OS} are not needed. Simply begin with input to Pin 9 and end the cycle by making Pin 21 high. (You must allow the "one-shot" timing to end, so the internal logic will reset.) The "one-shot" provides an envelope for the sound supplied by the mixer to the envelope generator and modulator. (An output pulse is available at Pin 1 to drive one TTL load, or with additional buffering it will drive an LED.)

ENVELOPE SELECT LOGIC

The Envelope Select logic determines the envelope that is applied to the mixer output according to the following table:

Envelope Select 1	Envelope Select 2	Selected Function
Pin 28	Pin 27	
L	L	VCO
L	H	Mixer Only
H	L	One-Shot
H	H	VCO with AC

DECAY CONTROL

The Decay circuitry alters the fall (decay) time of the envelope (selected according to the table above.) The decay ramp is triggered by each high-to-low transition of the "one-shot", VCO, and VCO with AC envelopes, and prolongs the sound at a decaying volume. (The decay volume begins after the "one-shot" timing ends.) When decay is desired, connect the Decay Timing Capacitor (C_D) to Pin 8. When connected to Pin 7 the Decay Control Resistor (R_D) determines the discharge rate of the timing capacitor (C_D), and the decay time of the envelope.

OUTPUT AMPLIFIER

The output amplifier is contained on the IC chip. The amplifier will deliver 125 mA (capacitively coupled) into an 8Ω speaker. The amplifier input (Pin 10) can be used to add several external signals. (NOTE: This is a current summing input only, not a voltage input, and should be capacitively coupled.)

OPERATING CHARACTERISTICS AT TA = 25°C AND VREG = 5.0V

PARAMETER	PIN	CONDITIONS/LIMITS	MIN	TYP	MAX	UNITS
ICC	12	VCC = 9.0V (Pins 26, 27 @ GND. All others open.)		15	21	MA
ICC	12	VCC = 9.0V (Pins 5, 7, 14, 17, 18, 22, 26, 27, @ GND. All others open.		19	26	MA
VREG (Regulated Output Voltage)	11	VCC = 9.0V External ILOAD = 5mA	4.5		5.5	V
VREG (Input Regulation)	11	VCC = 7.5V to 10V, External ILOAD = 5MA		150		MV
CONTROL INPUT CURRENTS:						
Noise Filter Control Resistor (RNF)	5	IRNF = 250μA MAX			250	μA
Decay Control Resistor (RD)	7	ID = 250μA MAX			250	μA
VCO Control Resistor (RVCO)	17	IRVCO = 250μA MAX			250	μA
SLF Control Resistor (RSLF)	18	IRSLF = 250μA MAX			250	μA
One-Shot Control Resistor (ROS)	22	IROS = 250μA MAX			250	μA
VIH High-Level Input Voltage			2.0		9.0	V
VIL Low-Level Input Voltage					0.8	V
System Inhibit	9	9.0V MAX			9.0	V
Mixer Select A	24	9.0V MAX		35	50	μA
Mixer Select B	25	9.0V MAX		35	50	μA
Mixer Select C	23	9.0V MAX		35	50	μA
SLF SYNC Select	26	9.0V MAX		35	50	μA
Envelope Select 1	28	9.0V MAX		35	50	μA
Envelope Select 2	27	9.0V MAX		35	50	μA
External VCO Cut-Off Voltage	15			2.35		V
Noise Clock Frequency	3		10	20		kHz
Peak-to-Peak Output Voltage Swing	13	RLOAD = 8 ohms AC coupled	1.6	2.0		V
TRIP POINTS (Capacitors)						
One-Shot Cap.	21			2.5		V
Noise Filter Cap.	6			3.2		V
SLF Cap.	19			2.3		V
VOL Low Level Voltage Output		IOL = −1.6 MA			0.4	V
VOH High Level Voltage Output		IOH = 40μA	2.4			V
One-Shot Output	1	(Can drive one TTL Load)				
VCO Output	2	(Can drive one TTL Load)				
Noise Clock Output	3	(Can drive one TTL Load)				
SLF Output	4	(Can drive one TTL Load)				

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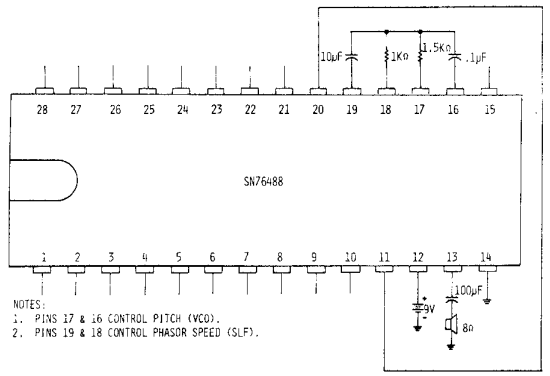
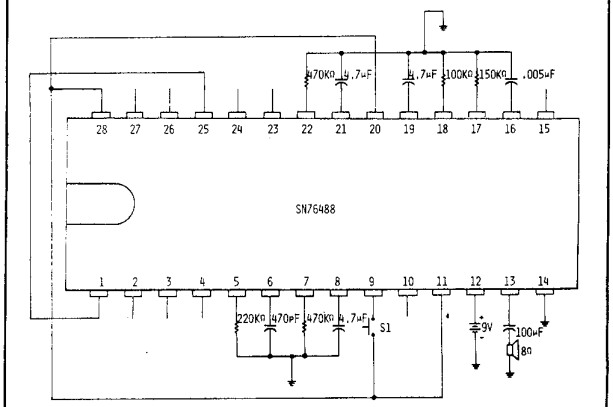
TYPICAL APPLICATIONS



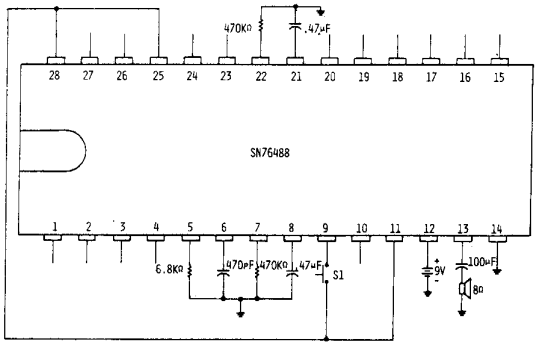
NOTES:
1. PINS 17 & 16 CONTROL PITCH (VCO).
2. PINS 19 & 18 CONTROL PHASOR SPEED (SLF).

FIGURE 1: PHASOR



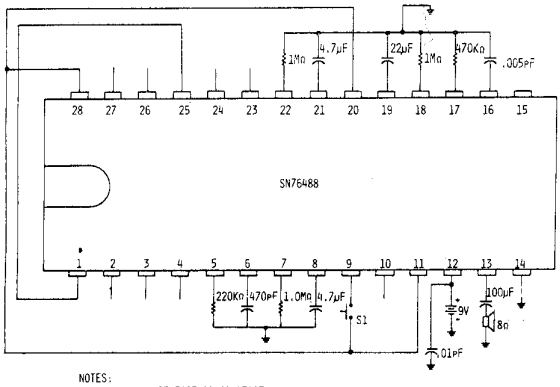
NOTES:
1. PRESS AND RELEASE S1 TO START SOUND.
2. DURATION OF PHASOR BLAST IS CONTROLLED BY PINS 21 AND 22 (ONE SHOT).
3. PHASOR SOUND IS CONTROLLED BY PINS 18 AND 19 (SLF) AND PINS 17 AND 16 (VCO).
4. EXPLOSION DECAY IS DETERMINED BY PINS 7 AND 8 (DECAY).

FIGURE 3: PHASOR AND EXPLOSION



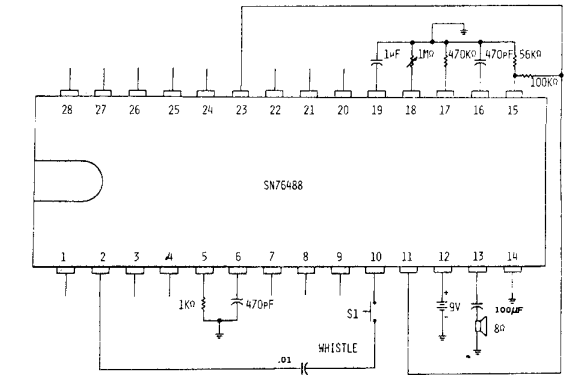
NOTES:
1. PRESS AND RELEASE S1 TO START SOUND.

FIGURE 4: GUNSHOT



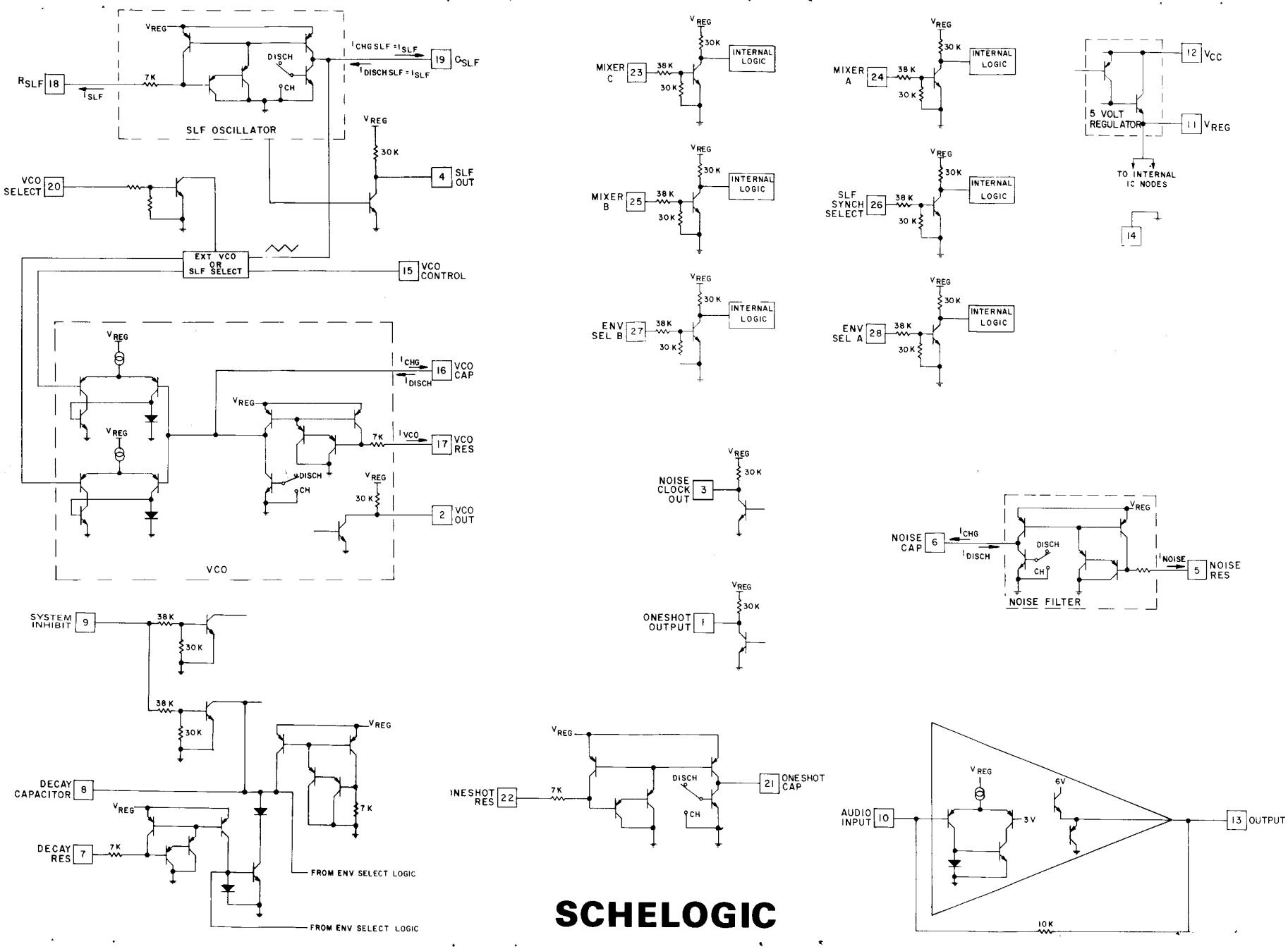
NOTES:
1. PRESS AND RELEASE S1 TO START.
2. PINS 20 AND 21 CONTROL LENGTH OF BOMB DROP (ONE SHOT).

FIGURE 2: BOMB DROP AND EXPLOSION



NOTES:
1. VARY SPEED BY ADJUSTING 1MΩ POT (SLF) ON PIN 18.
2. WHISTLE PITCH CONTROLLED BY RESISTORS ON PIN 15 (VCO EXTERNAL).

FIGURE 5: TOY STEAM ENGINE AND WHISTLE


SLF OSCILLATOR
VCO
SCHELOGIC