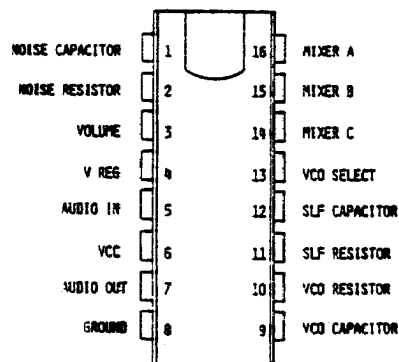


ADVANCED CIRCUITS  
TEXAS INSTRUMENTS INCORPORATED

SN76495  
COMPLEX SOUND GENERATOR

- Generates noise, tone, or low frequency based sounds, or combinations of these
- Sounds are defined by user via external components
- Allows custom sounds to be created easily
- Low power requirements
- Allows multiple sound system
- Compatible with microprocessor systems
- On board 125 MW audio amplifier



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004280

DESCRIPTION

The SN76495 complex sound generator is a monolithic chip combining both analog (bipolar) and digital (I<sup>2</sup>L) circuitry. It includes a noise generator, a voltage-controlled oscillator (VCO), and a super-low-frequency oscillator (SLF) together with a noise filter, mixer, audio amplifier, and control circuitry to provide noise, tone, or low-frequency sounds and any combinations of these. Programming is accomplished via control inputs and user-defined external components, which allows a wide variety of sound to be created and tailored for particular applications. This device may be used in a variety of applications requiring audio feedback to the operator including entertainment equipment such as arcade or home video games, pinball games, toys; consumer-oriented equipment such as timers, alarms, and controls; and industrial equipment for indicators, alarms, controls, etc.

Operation is from a 7.5 volts to 10.5 volt supply applied to a built-in regulator through the Vcc terminal, in which case a regulated five volts is available from the Vreg terminal to power a small amount of external circuitry, or to provide a high-logic-level voltage to logic inputs.

More detailed information on the functions of various parts of this device is found elsewhere in this data sheet in the section entitled "OPERATION".

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Absolute Maximum Ratings at Ta = 25 Degree C (unless otherwise noted)

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Supply Voltage, Vcc	12 Volts
Input Voltage: Logic Input	12 Volts
Capacitor Input	5.0 Volts
Resistor Input	5.0 Volts
Operating Free-Air Temp Range	0 Degree C to 70 Degrees C
Storage Temp Range	-65 Degrees C to 150 Degrees C

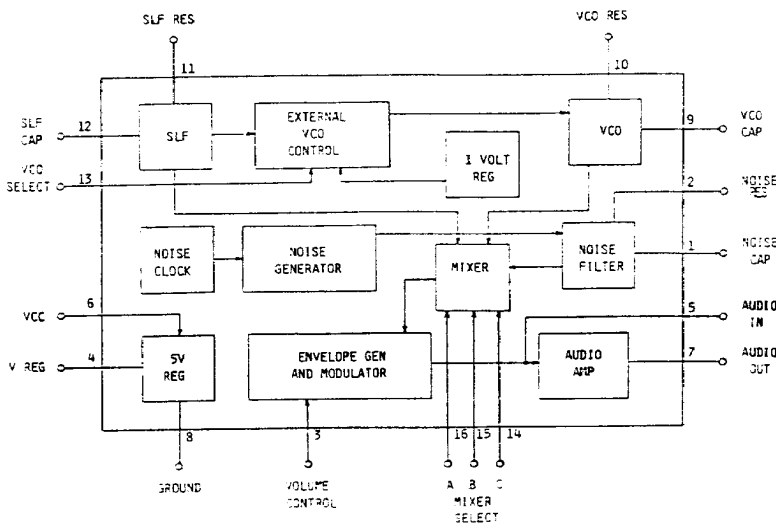
Recommended Operating Conditions

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	MIN	NOM	MAX	UNITS
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Supply Voltage, Vcc	7.5	9.0	10.5	Volts
Operating Free-Air Temp		25		Degree C
Amplifier Load AC Coupled	8.0			Ohms

Note 1: All voltage values are with respect to package ground terminal.

SN76495N BLOCK DIAGRAM



Electrical Characteristics at  $V_{cc} = 9$  Volts,  $T_a = 25$  Degrees C\*-----  
Unless otherwise noted

PARAMETER	PIN NOS.	TEST CONDITIONS	MIN	TYP	MAX	UNITS
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V <sub>ih</sub> High-level input voltage	14, 15, 16		2.0		9.0	V
V <sub>il</sub> Low-level input voltage (Note 2)	14, 15, 16				0.8	V
V <sub>opp</sub> Peak to Peak Output Voltage Swing	7	R <sub>load</sub> =8 ohms AC Coupled	1.6	2.0		V
V <sub>reg</sub> Regulation Output Voltage	4	V <sub>cc</sub> =9.0V, External I <sub>load</sub> = 5 mA	4.5		5.5	V
V <sub>reg</sub> Regulation	4	V <sub>cc</sub> =7.5V to 10V, External I <sub>load</sub> = 5 mA		150		MV
Trip Points:						
Noise Filter Capacitor	1			3.2		V
SLF Capacitor	12			2.3		V
External V <sub>co</sub> Cutoff Voltage	12			2.30		V
I <sub>ih</sub> High Level Input Current	14, 15, 16	V <sub>ih</sub> =2.0V		35	50	uA
Control Input Current (Note 3)	2, 10, 11		-1		-250	uA
I <sub>cc</sub>	6	V <sub>cc</sub> =9V Pins 2, 8, 10, 11 at GND. All other pins open.		19	26	mA

Note 2: Logic pins left open are normally low.

Note 3: All control pins have an internally connected series 7Kohm  
(typical value) current protection resistor.

## OPERATION

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Super Low Frequency Oscillator (SLF)  
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The SLF is normally operated in the range of 0.1 Hz to 30 hertz, but will operate up to 20 kHz. The frequency is determined by two external components, the SLF control resistor (Rslf) at pin 11 at ground and the SLF control capacitor (Cslf) at pin 12 at ground according to the following equation:

$$\text{Equation 1: SLF Frequency (Hz)} \approx .66 / (9\text{Kohm} + R_{slf}) \times C_{slf} \text{ at } V_{reg} = 5V$$

The SLF supplies two signals to other parts of the device. It feeds a 50% duty cycle square wave to the mixer, and it feeds a triangular wave to the external VCO of SLF select logic, where, if VCO select (pin 13) is at a low logic level, it is fed through to the VCO to modulate the frequency of that oscillator.

Voltage Controlled Oscillator (VCO)  
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The VCO produces a tone output whose frequency is dependent upon the voltage at the input of the VCO. This controlling voltage may be either the SLF output described above, an internal voltage producing a constant tone, or externally by placing a voltage on the SLF capacitor pin. The higher the voltage applied to the VCO, the lower the frequency of the VCO output.

The first mode, VCO controlled by SLF, is selected by placing the VCO select pin low and supplying both the VCO capacitor (CVCO) at pin 9 at ground and the VCO resistor (RVCO) at pin 10 at ground. Minimum frequency of the VCO is determined by the following equation:

$$\text{Equation 2: Minimum VCO Frequency (Hz)} \approx 0.60 / (9\text{Kohm} + RVCO) \times CVCO$$

The frequency range of the VCO is internally determined at an approximate ratio of 10:1, so that maximum frequency of the VCO will be approximately ten times the minimum frequency determined by the external components RVCO and CVCO.

The second method of supplying a control voltage for the VCO is to use an internal voltage preset at 1 volt. This mode is selected by taking VCO select to a high level. In this mode, the VCO puts out a constant tone determined by CVCO and RVCO in this relationship:

$$\text{Equation 3: } f_{VCO} \approx 1.45 / (RVCO + 9\text{Kohm}) \times CVCO \times 0.9V \text{ Hz}$$

A third method of controlling the voltage to the VCO is to apply the controlling voltage (Vext) to the SLF capacitor pin. This voltage level (0 to 2.30 volts) will determine the output frequency of the VCO. Output frequency in this mode is determined by this relationship:

$$\text{Equation 4: } f_{VCO} \approx 1.45 / (RVCO + 9\text{Kohm}) \times CVCO \times (V_{ext} - .1V) \text{ Hz}$$

## Mixer

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The mixer logic selects one or a combination of the inputs from the generators and feeds the output to the amplifier. The mixer performs a logical AND function on these sounds; therefore, the output of the mixer is not a combination of simultaneous sounds. The output of the mixer is determined by the logic levels at the mixer select inputs as shown in Table 1 below.

TABLE 1

MIXER SELECTS INPUTS			MIXER OUTPUT
A (PIN 16)	B (PIN 15)	C (PIN 14)	
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

H = HIGH LEVEL  
L = LOW LEVEL OR OPEN

Figure 1 is an example of how two signals would be combined by the mixer according to the logical AND function with the mixer select times set for SLF/noise (C input high, A and B inputs low).

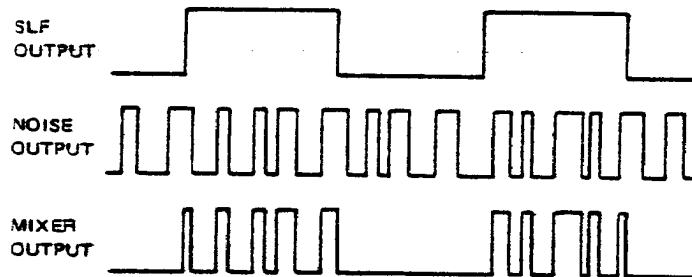


FIGURE 1

To obtain two sounds occurring simultaneously (e.g., car engine and siren or steam engine and whistle), multiplexing is required. The multiplexing is accomplished by switching the mixer select lines at a sufficiently rapid rate that the two sounds seem to occur at the same time. The frequency of the multiplexing should be above the human hearing range. A multiplexing drive signal with a 50% duty cycle is required to provide equal amplitudes for both sound functions.

#### Volume

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Output volume from the 76495 can be controlled by varying a voltage level on pin 3. This voltage level should range from 3.5 volts, for maximum volume, to .4 volts or below for no output. Under no circumstances should this pin be taken above 5 volts or below 0 volts. Voltages outside of this range could damage the unit.

#### Noise Generator/Filter

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The noise generator produces psuedo-random white noise that passes through the noise filter before being applied to the mixer. The variable-bandwidth low-pass filter has its cutoff point defined by the noise filter control resistor (Rnf) at pin 2 and the noise filter control capacitor (Cnf) at pin 1 according to the following equation:

$$\text{Equation 5: } f_{\text{Cutoff}} \text{ (Hz)} \approx .43 / (9\text{Kohm} + R_{\text{nf}}) \times C_{\text{nf}}$$

#### Output Amplifier

-----

The output amplifier is contained entirely on chip. The amplifier operates in a transimpedance mode and has a push-pull output capable of delivering 125 mA into a capacitively coupled 8 ohm load. This produces a two volt peak to peak output signal. The amplifier input (pin 5) can be used to sum several external current signals. If the signals are composed of a varying voltage they must first be converted to current signals. This can be accomplished by using a resistor in series between the external source and the input (pin 5). The relationship of this resistor value (R series) to the external signal voltage (V max) is given by the following equation:

$$-100 \text{ uA} < V_{\text{max}} - 3\text{V} / R_{\text{series}} < 100 \text{ uA}$$

Gain of the amplifier can be controlled by adding a resistor in parallel to the internal 10 Kohm feedback resistor. This will decrease gain and allow a larger input current. A graph of power delivered to an 8 ohm speaker as a function of coupling capacitance and frequency is shown in Figure 7.

#### Regulator

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The circuit will operate from a single supply (pin 6). An internal 5 volt regulator allows the use of a 7.5 volt to 10.5 volt unregulated supply applied to Vcc (pin 6) and in addition to supplying power for the chip, the internal regulator will provide a 5 volt regulated supply of up to 5 mA from Vreg (pin 4) for use outside the integrated circuit.

## FUNCTION SUMMARY

DESCRIPTION -----	PIN NO. -----	LIMIT -----	FUNCTION -----
SLF Control Resistor (Rslf)	11	IRslf=250uA (See Note 4)	$IRslf = 2.75 \text{ Volts} / (9 \text{ Kohm} + Rslf)$
SLF Control Capacitor (Cslf)	12		$fslf = .66 / (9 \text{ Kohm} + Rslf) \times Cslf$
VCO Select	13	9V Maximum	Input Low (Note 5) = VCO Controlled by SLF Input High (Note 5) = Internal Voltage Controls VCO
VCO Control Resistor (RVCO)	10	IRVCO=250uA max.	$IRVCO = 2.75 \text{ Volts} / (9 \text{ Kohm} + RVCO)$
VCO Control Capacitor (CVCO)	9		$fslf = .60 / (9 \text{ Kohm} + RVCO) \times CVCO$
VCO External Control	12	0 to 2.30 Volts	Increase in Voltage Decreases VCO Frequency
Noise Filter Resistor (2Rnf)	2	IRnf=250uA max.	Low Pass Filter
Noise Filter Capacitor (Cnf)	1		$IRnf = 2.75 \text{ Volts} / (9 \text{ Kohm} + Rnf)$  $f_{cutoff} = .43 / (9 \text{ Kohm} + Rnf) \times Cnf$
Mixer Select A	16	9V Maximum	Selects one or a combination of generator outputs. Mixer output is a logic "AND" function of mixer inputs.
Mixer Select B	15	9V Maximum	
Mixer Select C	14	9V Maximum	
Volume	3	.4 to 3.5 Volts	Controls output volume. 3.5 volts give maximum output. Minimum voltage (Off) at .4 volts.

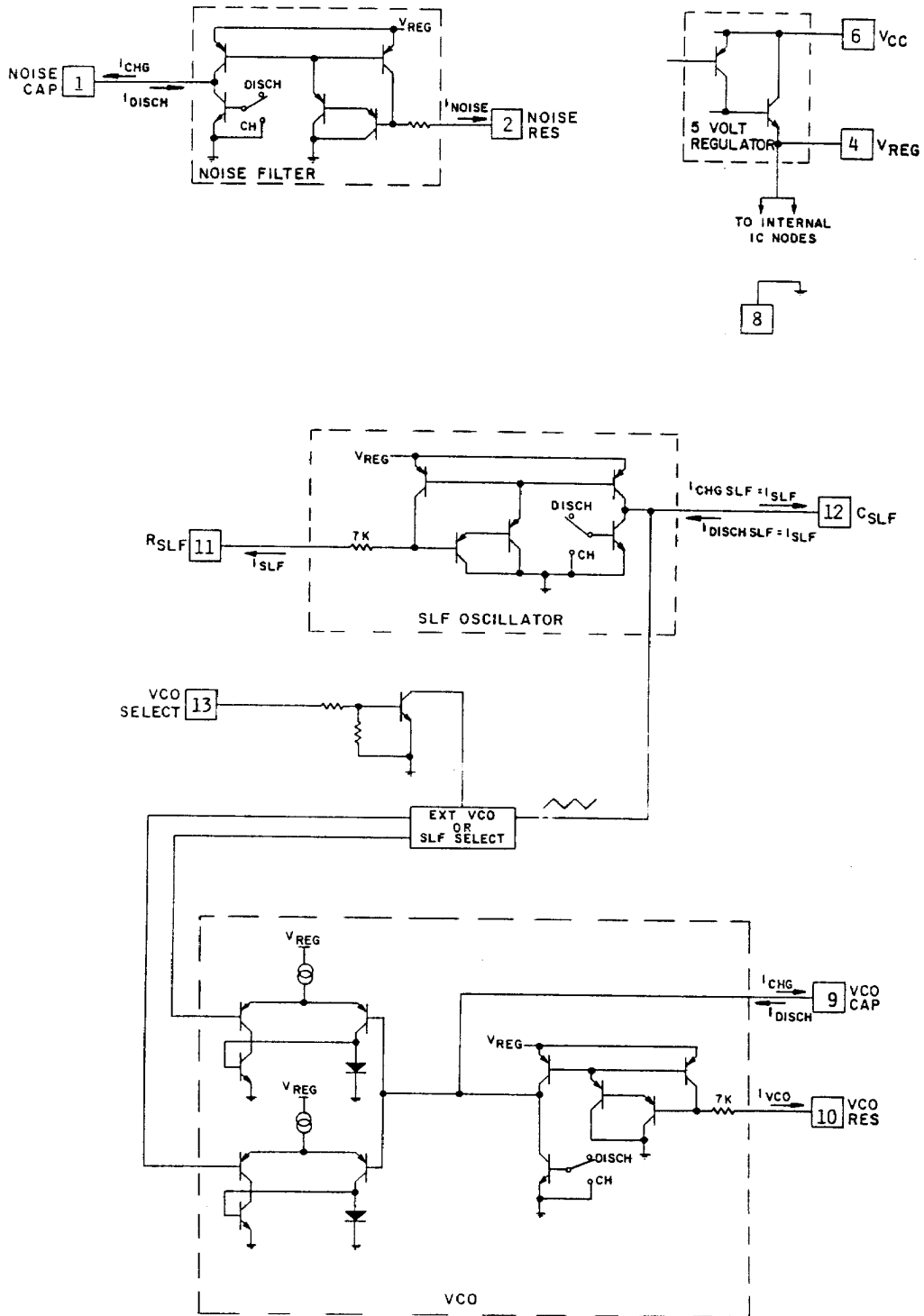
Amplifier Input	5	Can be used to sum externally applied signals. Amplifier output is push-pull and is designed to swing 2 volts peak to peak when driven internally by the sound generators.
Amplifier Output	7	

Note 4: To reduce sound variations from chip to chip, it is suggested that control resistors be large in value to negate the effects of the internal current protect resistors. This also reduces the value of the control capacitors.

Note 5: As defined by  $V_{il}$  and  $V_{ih}$  in electrical specification.

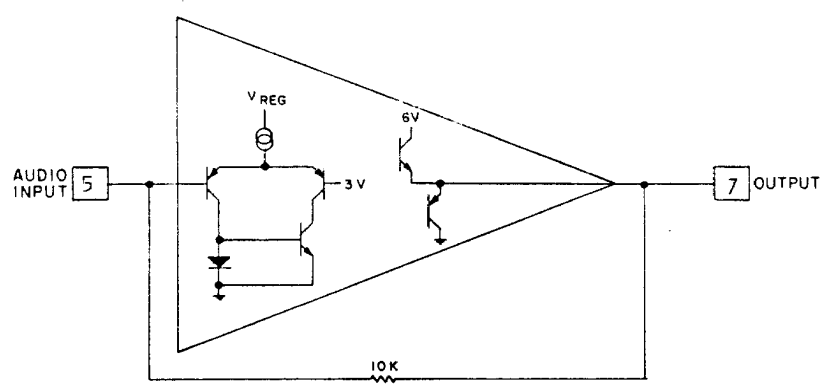
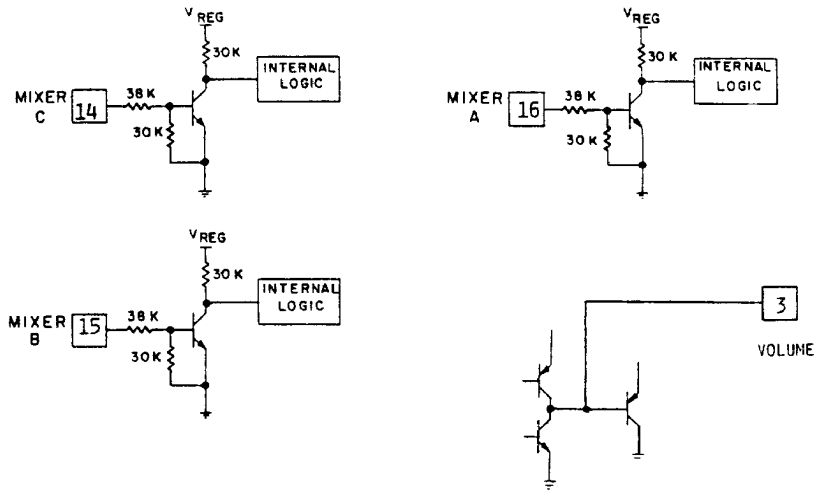


# SN76495N I/O Interface



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# SN76495N I/O Interface



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