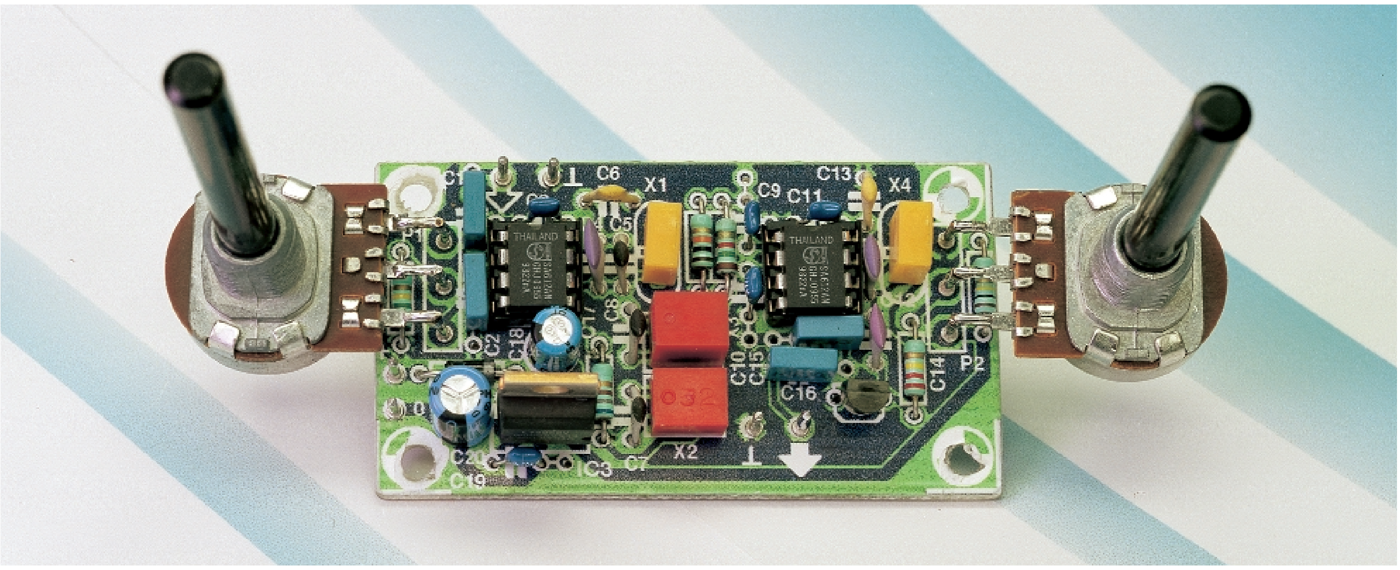
voice shifter

original effects unit

Design by G. Baars



Effects units are and remain popular, especially with pop musicians. These units, phasers, clippers, flangers, and so on are used to make a specific sound or range of sounds. This article describes how such an effects unit may be built from simple means. It is another application of the pitch shifting technique as used in phasing, chorus and flanging, but, unlike true pitch shifting in which a constant interval is created above or below the input signal, it shifts a specific audio band.

It has been said before, and will no doubt be said again many times: we live in a funny world. Most music lovers go out of their way and are prepared to spend a lot of money to achieve music reproduction with as little distortion as possible.

There are, however, others (lovers of a different type of music) who go to great lengths to get away from high fidelity sound. These people feel that the sound processing must match their ideas of what music should be. They try anything and any means to subject voice and instrument sounds to a variety of sound shaping processes that distort the original signal, sometimes by up to 100 per cent.

The voice shifter described here is suitable for seamless connection to a variety of current (commercial) effects units. This is because the applied audio signal is shifted in pitch (frequency). Although this shift does not amount to more than 500 Hz, it is sufficient in practical applications to provide very interesting sound effects with electronic music, but particularly with singing voices. The range of an average voice may be shifted from a rasping male voice to a child’s falsetto.

Principle of design

So as to keep the circuit reasonably simple, the design caters for a bandwidth extending from 500 Hz to 6 kHz. This is the main frequency band for music and also contains the usual human voice register.

The incoming audio signal is combined in a mixer with a carrier at a frequency of 451.5 kHz. As most readers will know, combining two frequencies in a mixer produces output frequencies equal to the sum and difference of the two input frequencies. In the present case, this means bands of 452–458 kHz 445–451 kHz.

As the mixer used is a double-balanced type (see box), the carrier of 451.5 kHz is suppressed. This results in output (side) bands as shown diagrammatically in Figure 1a. Since only one side band is needed (and it does not matter which), a filter is needed to suppress the unwanted band. A further look at Figure 1a shows that thecentre of the righthand sideband is at exactly 455 kHz. That frequency is a well-known one for which there are a plethora of ceramic elements available that lend themselves ideally to producing an excellent, selective 455 kHz band-pass filter.

When the frequency bands in Figure 1a are passed through such a band-pass filter, the residual sideband, that is, the upper one, is shown in Figure 1b.

Two matters remain to be done: the pitch must be shifted and the band of 452–458 kHz must be converted to an audio frequency band. Both may be achieved by applying the residual sideband to a product detector. This is really a kind of mixer in which a carrier wave, variable between 451 kHz and 452 kHz, is added. The result is an audio band 6 kHz wide, which can be shifted by ±500 Hz as shown in Figure 1c. It is this shift that produces the desired effect.

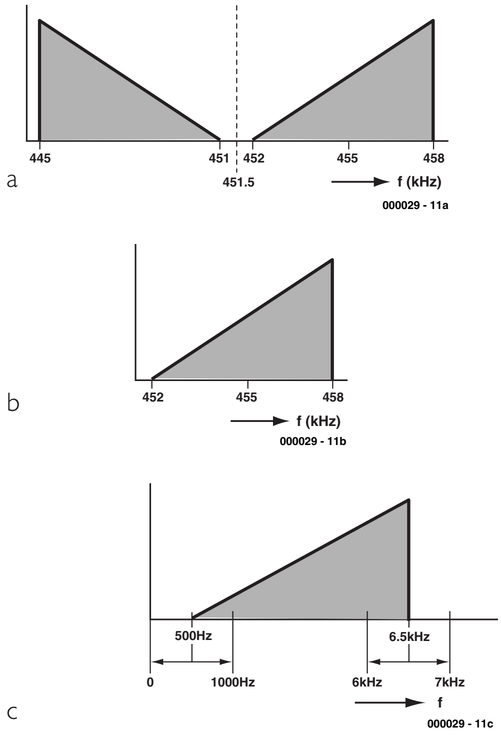


Figure 1. When an audio signal is mixed with a high frequency carrier wave, two sidebands result (1a), of which one, the lower, is suppressed (1b). The residual upper sideband is processed with the aid of a variable beat frequency oscillator (BFO).

Circuit description

Inspection of the diagram in Figure 2 shows that the circuit resembles a typical radio frequency design rather than an audio frequency one.

The circuit is based on two integrated circuits, IC1 and IC2, which are of a type that is normally found only in receivers and transceivers. The same applies to the ceramic filters and resonators. Because of its resembling a radio frequency design, some readers may note that the circuit is very much like that of a single sideband (SSB) exciter followed by an SSB detector with variable beat frequency oscillator, BFO.

The input signal is mixed with the 451.5 kHz oscillator frequency in IC1. The oscillator frequency is generated by elements in the IC and ceramic resonator X1. Note that although the resonant frequency of the resonator is 455 kHz, this is pulled down to the desired 451.5 kHz by capacitors C4–C6.

The filter that suppresses the lower sideband of

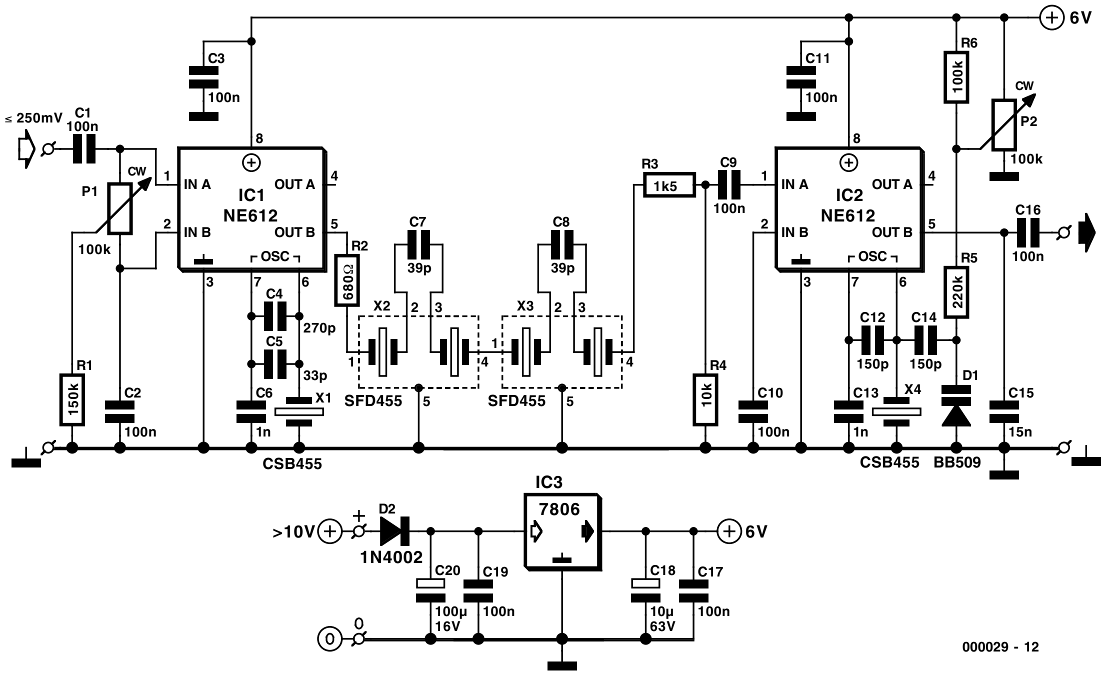


Figure 2. The circuit diagram of the voice shifter shows the simplicity of the design.

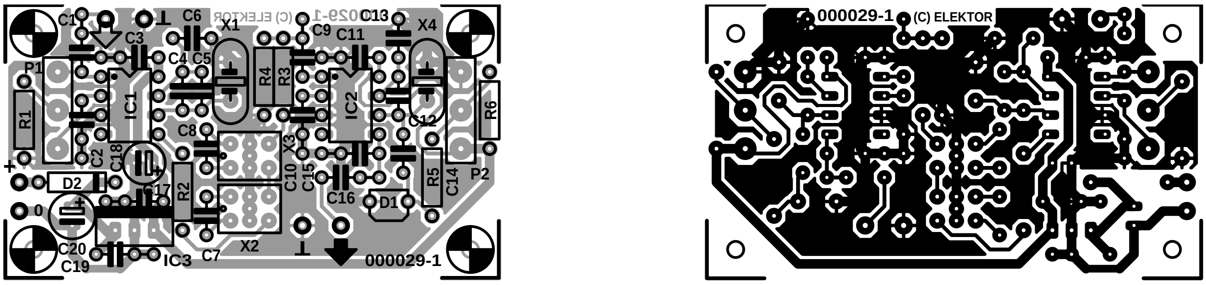


Figure 3. The printed-circuit board for the voice shifter is not available ready made.

the mixer output consists of elements X2 and X3. These are relatively inexpensive items that work very well in this application. Of course, if two small 455 kHz filters are already to hand, they may well do very nicely.

The product detector which, as already mentioned earlier, is a kind of mixer also, is formed by IC2, and is of the same type as IC1. In this case, however, internal elements in conjunction with resonator X4 form a beat frequency oscillator. The frequency of this may be varied with the aid of variable capacitance (varicap) diode D1 and potentiometer P2 over the frequency band 451–452 kHz.

Construction

The voice shifter is best constructed on the printed-circuit board shown in Figure 3. However, this board is not available ready made and must, therefore, be made by the constructor. Fortunately, this is straightforward.

The terminals for input, output, supply voltage, and potentiometers are clearly marked so as to prevent any mistakes.

The reader may also note that in the design of the board account is taken of other, newer types of filter in the X2 and X3 positions, which may have six instead of five pins. There is, therefore, sufficient provision for experimenting with different filter types.

Input and output connections should be made in single screened audio cable.

The supply voltage may be provided by dry or rechargeable batteries, or a mains adaptor. The circuit draws a current of only about 10 mA, so that a battery supply is perfectly all right.

If a mains adaptor is used, bear in mind that the circuit already contains a voltage regulator, IC3, so that the adaptor need not be a regulated type.

The supply voltage must be at least 10 V, but one higher than 12 V is unnecessary. In any case, make sure that the working voltage of C20 is not exceeded.

Setting controls

Network R1-P1 serves to balance the operation of mixer stage IC1, which optimizes the suppression of the carrier wave. Setting P1 to the required position is best carried out by ear. This is done by setting BFO control P2 to one of its extreme positions to make the carrier wave audible as a 500 Hz tone. Balance control P1 is then varied until the loudness of the tone is a minimum.

When P1 is set correctly, the shift effect is controlled with P2. Clearly, there are no rules for this, because it is purely a question of personal taste and requirements.

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COMPONENTS LIST

Resistors:
R1 = 150kΩ
R2 = 680Ω
R3 = 1kΩ5
R4 = 10kΩ
R5 = 220kΩ
R6 = 100kΩ
P1,P2 = 100kΩ linear potentiometer

Capacitors:
C1,C2,C16 = 100nF MKT (Siemens)
C3,C9,C10,C11,C17,C19 = 100nF ceramic
C4 = 270pF
C5 = 33pF
C6,C13 = 1nF ceramic
C7,C8 = 39pF
C12,C14 = 150pF
C15 = 15nF MKT (Siemens)
C18 = 10µF 63V radial
C20 = 100µF 16V radial

Semiconductors:
D1 = BB509 (ITT)*
D2 = 1N4002
IC1,IC2 = NE612N/SA612AN (Philips)*
IC3 = 7806

Miscellaneous:
X1,X4 = CSB455 (Murata)*
X2,X3 = SFD455A (Murata)*

*) Available from. Barend Hendriksen Elektronica, P.O. Box 66, NL-6970-AB Brummen, The Netherlands. Tel. (+31) 575 561866, fax (+31) 575 565012. Web site: http://www.xs4all.nl/~barendh/

Integrated circuit NE612/SA612

Integrated circuit NE612/SA612 is a double balanced mixer that may be used right up to the very high frequency (VHF) region. It has an internal local oscillator and a voltage regulator.

The device is intended primarily for use in low power communications systems using signal frequencies up to 500 MHz and oscillator frequencies up to 200 MHz.

The mixer proper is a multiplier operating on the Gilbert Cell principle and provides a gain of 14 dB at 49 MHz. The Gilbert Cell is formed by a differential amplifier that drives a balanced switching stage.

The internal local oscillator may be controlled by a quartz crystal, a ceramic resonator, or an LC circuit. It may also be used as a buffer for an external oscillator.

The low current drain makes the device eminently suitable for use in battery powered applications, such as mobile telephones, portable radios, VHF transceivers, and communication receivers.

The device is available in an 8-pin plastic DIL case and as an 8-pin SMD component.