SubAudible
Tone Encoder
Model SEN-6
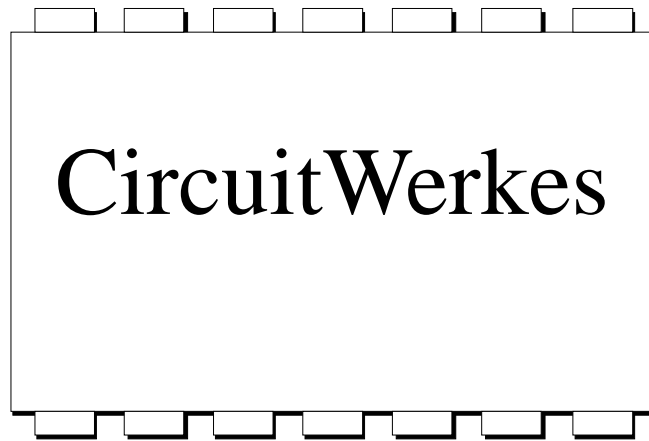
CircuitWerkes

Technical Manual

The CircuitWerkes Subaudible Tone Encoder

Description

The CircuitWerkes Subaudible Tone Encoder is a single channel tone generator capable of encoding 25Hz, 35Hz and 25/35Hz combination tones for signalling and remote control of automated systems over satellite, RPU and other media capable of passing subaudible signals. The unit has individual inputs for 25Hz, 35Hz and combination tone generation. In addition to standard 25 and 35Hz tones, the SEN-6 can, with external filtering, generate 50, 75 and combination 50/75Hz tones. Outputs are provided for low tone, high tone and shifted (50/75) tone mode. An LED indicator on the front of the box illuminates any time a tone is being sent. The SEN-6 is designed to be the last device in an audio chain and all program audio should be passed through the SEN-6. Internal notch filters eliminate subaudible content from the program material. The audio input can accept balanced or unbalanced audio at input levels of -20dBm to +8dBm. The output is balanced, transformerless and can drive a 600 ohm load. Subaudible program content is typically attenuated by 40dB at the audio output and it is short-circuit protected.

Installation & Setup

CONNECTIONS:

Connections to the subaudible tone encoder are fairly straight forward. Your audio passes through the encoder via the Audio In and Main Out jacks. When the input is unbalanced, the (+) input lead should be tied to ground and the input driven via the (-) input. Power inputs are brought out to both barrier strips and a coaxial power connector. Both of the power connectors are in parallel with each other, so only one power source at a time can be connected to the SEN-6. Power is provided by the included "wall-wart." Connection can be made to either port, depending on which type of adapter was supplied with your encoder. The SEN-6, as is the case with most CircuitWerkes products, uses an internal bridge and Voltage regulators so, it can be powered with any supply of 17-24 Volts AC or DC capable of delivering 150mA.

All control inputs are opto-isolated and require simple ground closures to operate. Indicator outputs are also opto-isolated and and operate whenever their specific tone is generated. An additional barrier strip position is for the encoder enable function. This input is active if Jumer J7 is removed. When J7 is removed and there is nothing connected between the enable input and ground, no tones will be produced. This feature lets you prevent accidental closures, except at pre-determined windows. If J7 is removed, the SEN-6 must have a connection between the enable input and ground for it to output tones. J7 simply parallels the external input connector. If J7 is on (the default) the SEN-6 will operate whenever its input is activated. Finally, in addition to the screw terminals, a D-9 connector duplicates the control and signal functions (See page 5).

Indicator outputs for for low tone, high tone and shifted (50/75) tones are ground sinking optocoupler outputs. These outputs are rated at 24V and 100mA. If higher Voltages or more current is to be switched, an external slave relay is highly recommended.

Audio input gain, output level and tone insertion level are controlled by front panel pots. An LED indicator is provided to show you when audio is present and when both input and output clipping are happening.

Jumper J2 removes subaudible tones from the program path when off. A second output jack labelled "Test Mode Out" contains only raw subaudible tones, minus program material. By removing J2 and monitoring the "Test Mode Out" connector, you can test and adjust the level of your tone generator without getting tones on the air or removing the encoder from your air chain.

J5 selects whether the Input LED detects presence or input clipping.

Tone duration is user selectable via J6 from .75sec. to 2 secs. via the 5 position jumper. When all positions are un-jumpered, the encoder produces a 10 second tone for testing.
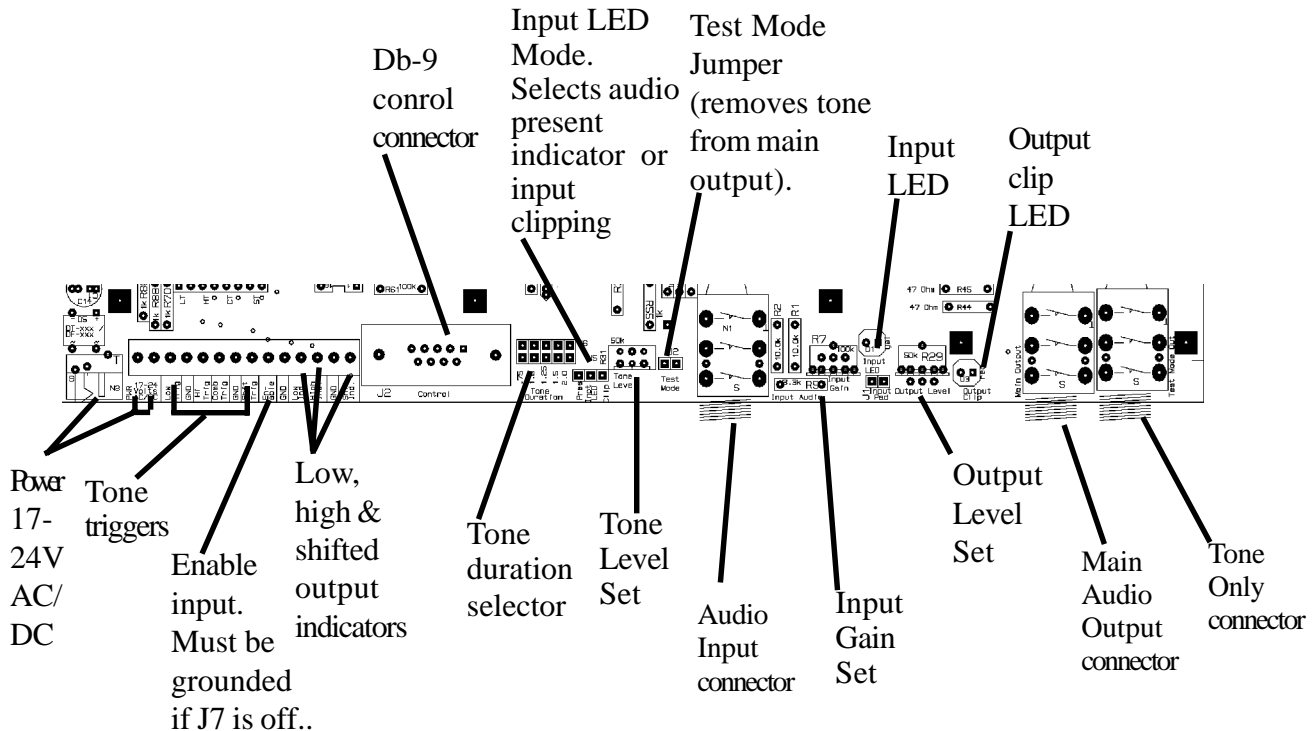
SETTING LEVELS:

The SEN-6 can accept a wide variety of input levels and its output driver can supply peak levels of up to +16dBm into a 600 Ohm load.   Decisions on how to set levels are based on how you will use the encoder, but one cardinal rule always applies: Tones must be at least 10dB **hotter** than surrounding program material in order to be reliably detected. Actually, we recommend that tones not be transmitted over other program material at all. However, you *may* be able to transmit tones over music buffers as long as the music has faded by 10 to 20 dB before the tone is generated. This should only be tried if automatic ducking is employed and/or the tones are automated so that they only occur over tightly controlled and repeatable program events that have been shown to be reliable. Although it might also be possible to reduce your normal program material by 10 to 20dB and transmit the tones over unfaded programming, we would strongly recommend against trying that. You would pay a penalty in excess noise from reducing your peak program levels. Also, there is a lot of room for misadjustment of individual decoders downstream.

The SEN-6 has a maximum dynamic range of about 90dB. By selecting the highest input level that does not cause clipping of the input stage, you will get the maximum signal to noise ratio from the SEN-6. Audio input gain is controlled by R7 and should be adjusted until the audio presence LED is flashing most of the time with normal program material, but WITHOUT lighting the LED in clipping mode on peaks.   After the input is set, adjust the output level control for the desired output amplitude. This control is variable from 0 to about +16dBm. The input and output clipping indicators light about 0 to10dB below the actual clipping threshold, however, unprocessed audio usually has peaks exceeding 10dB above reference, so if these indicators are flashing with program peaks, you probably have distorted output.   The audio presence LED initially turns on at around 20-25dB below the input clip level.

The subaudible tone amplitude is controlled only by the tone level control.   Neither the input *or output* level controls affect the tone gain. One way to set the tone level is: insert a tone or program audio at normal levels & set the input control until the audio LED is on most of the time in presence mode, but not on at all in the clip mode. Next, set the output control for the correct output amplitude. Remove the input audio and set the tone level control for the correct (usually = nominal pgm level or a little more) output level. Remember, tones must be undistorted and at least 10dB hotter than any underlying program material to work properly.   While tones may not have to be sent at +10dBm, neither should they be sent at -20dBm. Tones can always be monitored & measured at the tone only output connector.

SEN-6 Connector & Controls Layout (Top View)

Input LED Mode. Selects audio present indicator or input clipping

Test Mode Jumper (removes tone from main output).

Db-9 conrol connector

Input LED

Output clip LED

Power 17-24V AC/ DC

Tone triggers

Enable input. Must be grounded if J7 is off..

Low, high & shifted output indicators

Tone duration selector

Tone Level Set

Audio Input connector

Input Gain Set

Output Level Set

Main Audio Output connector

Tone Only connector

Note: The front panel of the SEN-6 has an LED indicating tones being generated and a single LED for power.

4

```
   5      4      3      2      1
   O      O      O      O      O

      9      8      7      6
      O      O      O      O
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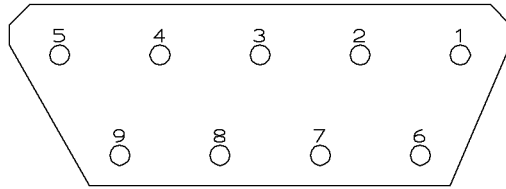
1 = Lo tone trigger   6 = Ground
2 = Hi tone trigger   7 = Shift sink
3 = Combo tone trigger 8 = High sink
4 = Shift   9 = Low sink
5 = Enable

Connections on the Db-9 parallel those on the screw terminals.

CircuitWerkes Subaudible Tone Encoder Audio Wiring Diagram

<u>Important note about phasing:</u> There are two important characteristics to consider about the SEN-6:
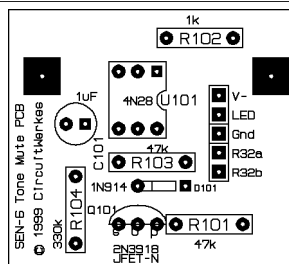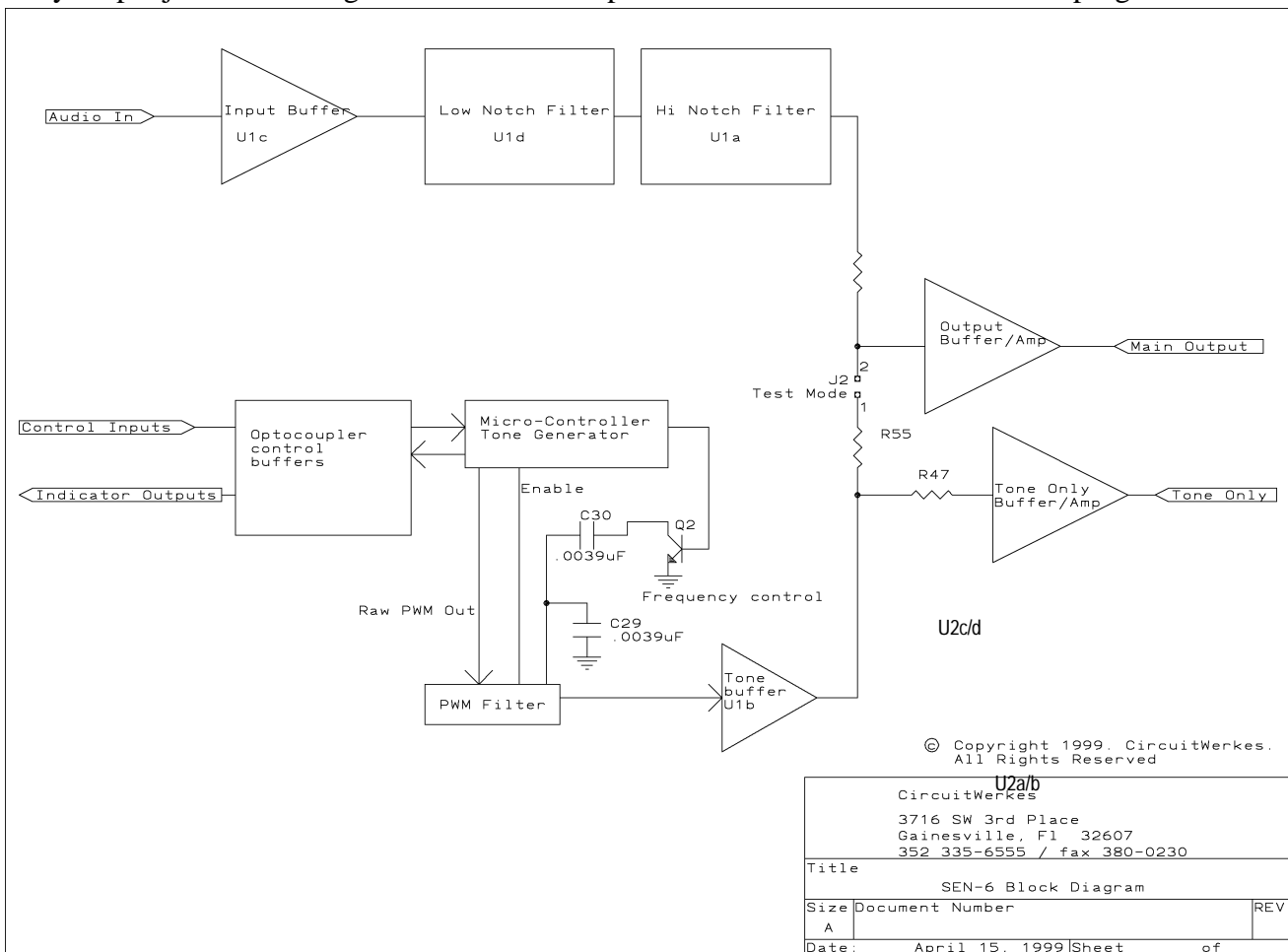
1. The notch filters exhibit significant phase shift at low frequencies. You should not use the SEN-6 on stereo program lines unless you have one on each channel. Also, when mixing filtered and unfiltered program paths, you will experience some cancellation of frequencies below 150Hz.

2. The actual output phase is directly related to the number of amplifiers that are cascaded. In the SEN-6, one amplifier is used for each of the filter sections, so removing one filter rotates the phase by 180 degrees. The input and output are in phase with one amplifier removed. If you use the SEN-6 in the factory default mode with both filters in place, the output will be out of phase, so be sure to wire your output jacks accordingly.

Input

1/4" TRS (phone) PLUG

TIP

SLEEVE   RING

Tip is Balanced (or Unbalanced) + In
Ring is Balanced - in.
Sleeve is audio ground and should be connected to your source's ground.

If your audio is unbalanced, you should drive ring and tie tip to sleeve for proper operation.   Note that the audio will be in phase with the output when both filters are used (default).

Output

1/4" TRS (phone) PLUG

TIP

SLEEVE   RING

Tip is Balanced Out +.
Ring is Blanced Out -.
Sleeve is left floating and may be tied to ground on the other end.

Do not connect either driven output (+) or (-) directly to ground! These outputs are short circuit protected, but prolonged shorting will cause overheating   and may also degrade audio performance.

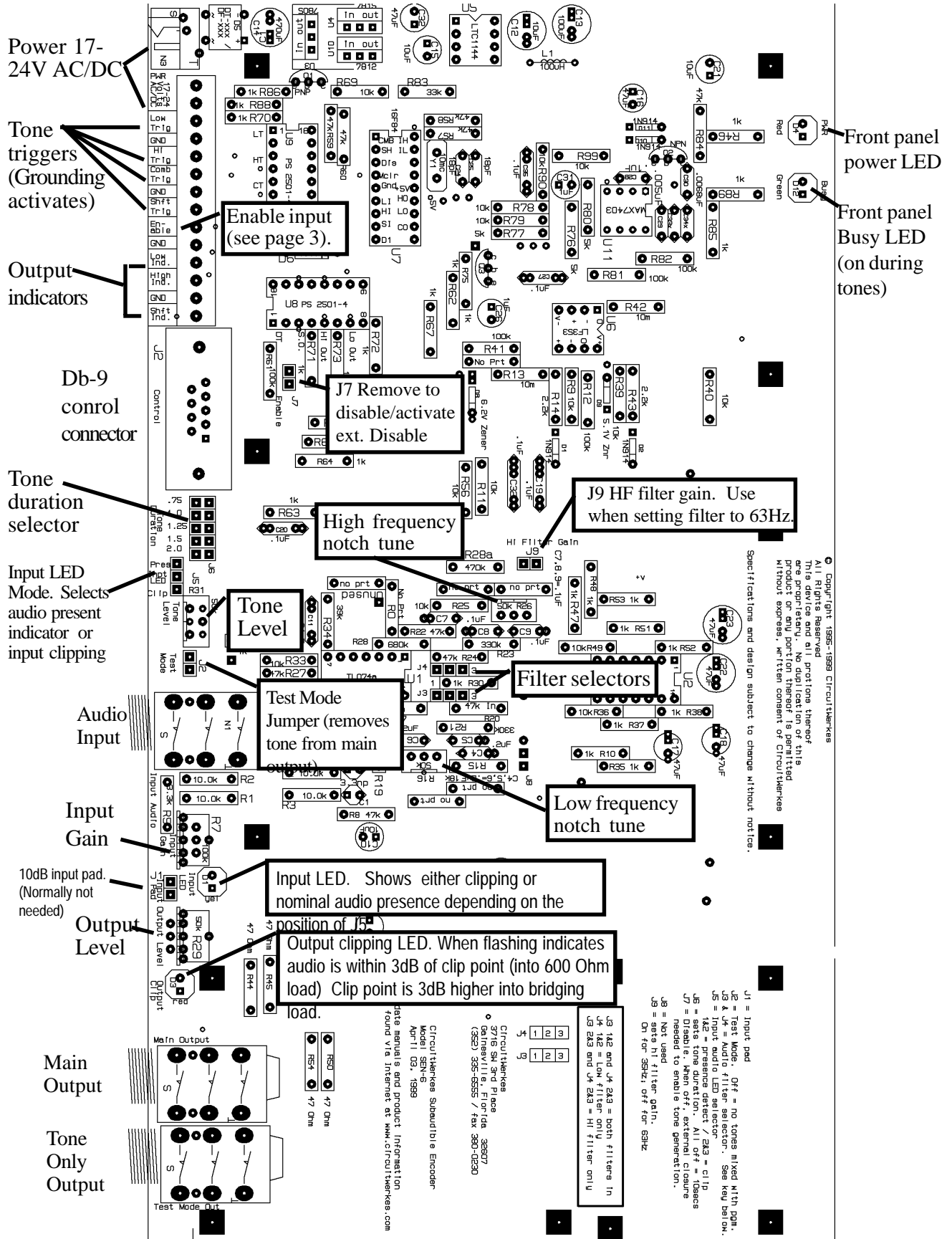| Size	Document Number	REV
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Short Theory of Operation

Input audio is buffered by U1c and sent to the low frequency notch filter, U1d. The output of the low frequency filter goes to the high frequency notch filter, U1a. A series of jumpers, J3 & J4 allow the user to use one or both notch filters. Program audio, with subaudible content removed, is then fed to the output mixer/buffer/amp, U2c & d.

Control inputs and indicator outputs are generated by the microcontroller and buffered by TIL-199b optocouplers. The subaudible tones are first generated as raw PWM in the microcontroller. From there tones are levelled and pre-filtered then passed to a switched capacitor low pass filter which removes the PWM distortion. The tones then go to a daughter board which mutes the first few milliseconds of tone and then ramps the audio up to full amplitude, avoiding pops when the tone is first produced. By ramping up the tone audio, detection is improved on some decoders.   Output from the mute circuit is sent to buffer amplifier, U1b. The output of U1b is sent directly to the tone only output jack and through J2 to the main output buffer where it is mixed with the program audio.
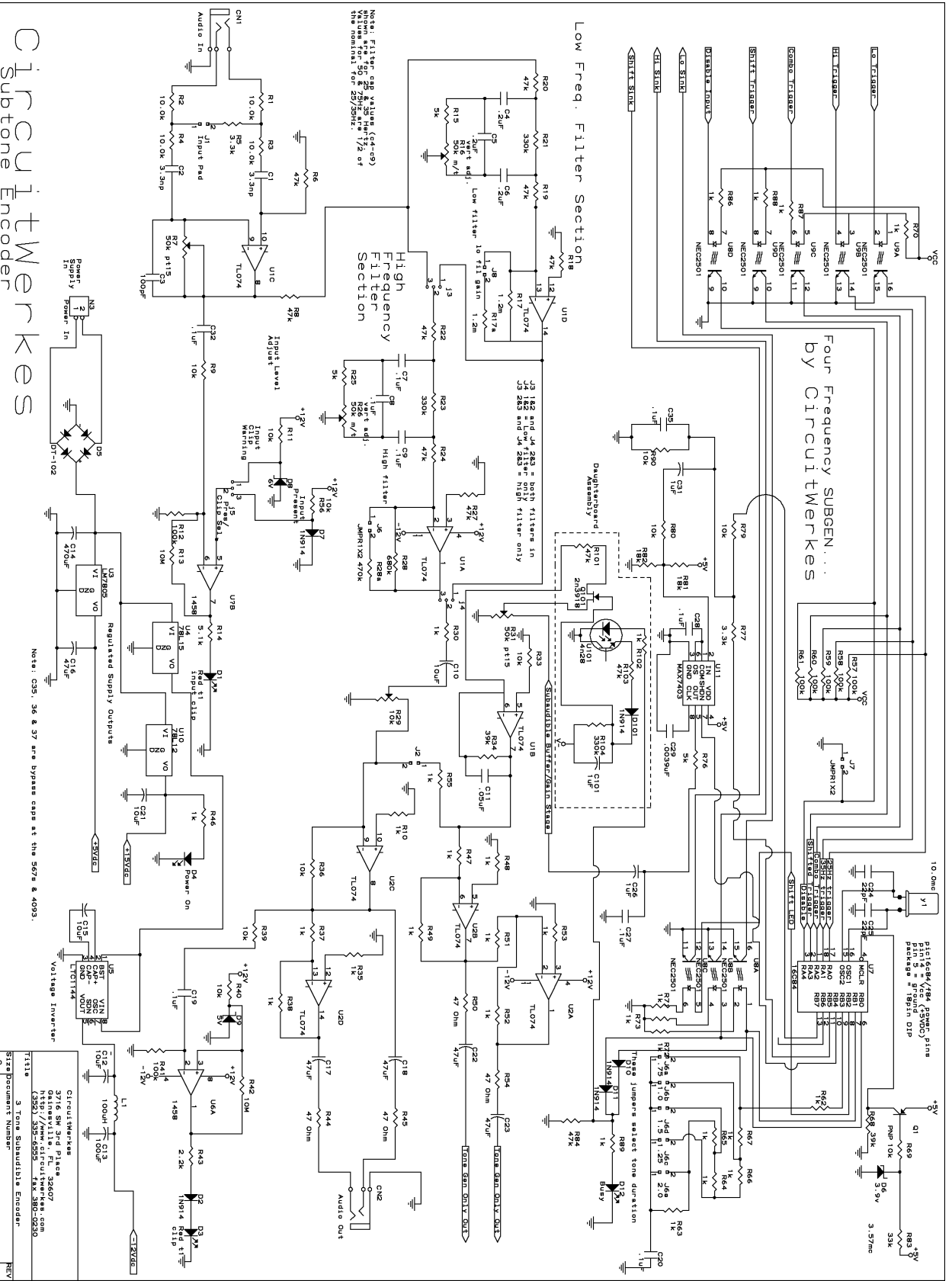

SEN-6 Mute PCB Layout

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SEN-6 Componant Locator

Power 17-24V AC/DC

Tone triggers (Grounding activates)

Output indicators

Db-9 conrol connector

Tone duration selector

Input LED Mode. Selects audio present indicator or input clipping

Audio Input

Input Gain

10dB input pad. (Normally not needed)

Output Level

Main Output

Tone Only Output

Enable input (see page 3).

J7 Remove to disable/activate ext. Disable

Tone Level

Test Mode Jumper (removes tone from main output)

High frequency notch tune

J9 HF filter gain. Use when setting filter to 63Hz.

Filter selectors

Low frequency notch tune

Input LED. Shows either clipping or nominal audio presence depending on the position of J5.

Output clipping LED. When flashing indicates audio is within 3dB of clip point (into 600 Ohm load) Clip point is 3dB higher into bridging load.

Front panel power LED

Front panel Busy LED (on during tones)

Specifications and design subject to change without notice.

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Gainesville, Florida 32607
(352) 335-6555 / fax 380-0230

date manuals and product information found via Internet at www.circuitwerkes.com

CircuitWerkes
Subaudible Encoder
Model SEN-6
April 03, 1999

J1 = Input pad.
J2 = Test Mode. Off = no tones mixed with pgm.
J3 & J4 = Audio filter selector. See Key below.
J5 = Input audio LED selector.
1&2 = presence detect / 2&3 = clip
J6 = sets tone duration. All off = 10secs
J7 = Disable. When off, external closure needed to enable tone generation.
J8 = Not used.
J9 = sets hi filter gain.
On for 35Hz, off for 63Hz

J3 1&2 and J4 2&3 = both filters in
J4 1&2 = Low filter only
J3 2&3 and J4 2&3 = HI filter only
J4 1&2 and J4 2&3 = HI filter only

SEN-6 Subaudible Tone Encoder Schematic

Four Frequency SUBGEN...
by CircuitWerkes

CircuitWerkes
Subtone Encoder

Low Freq. Filter Section

High Frequency Filter Section

Note: Filter cap values (C4-C9) shown are for 50 & 75 Hertz. Values for 50 & 75Hz are 1/2 of the nominal for 25/35Hz.

Daughterboard Assembly

Subaudible Buffer/Gain Stage

Regulated Supply Outputs

Note: C35, 36 & 37 are bypass caps at the 567s & 4093.

Three jumpers select tone duration

J3 1&2 and J4 2&3 = both filters in
J3 2&3 and J4 2&3 = low filter only
J3 2&3 and J4 1&2 = high filter only

pic16c84/f84 power pins
pin14 = Vcc (+5VDC)
pin 5 = ground
package = 18pin DIP

Input Level Adjust

Voltage Inverter

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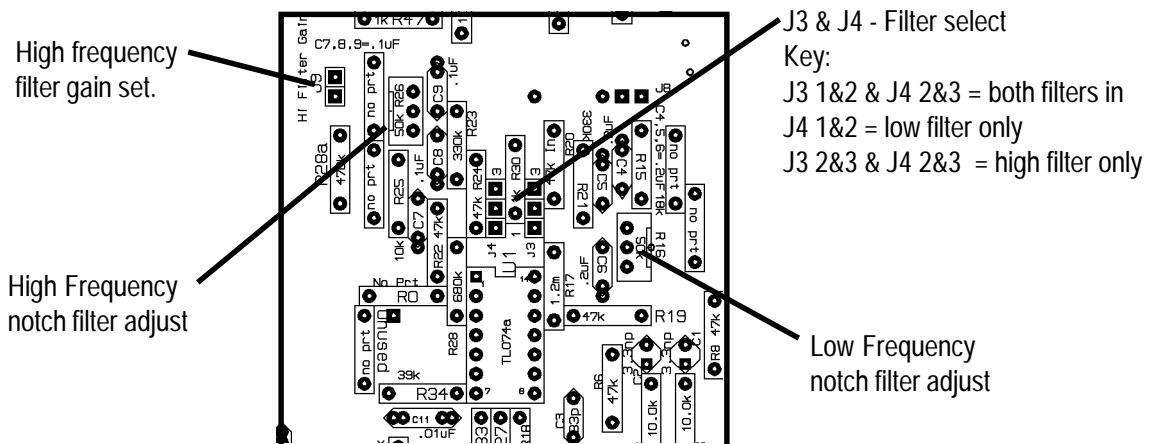
Alignment

Levels.

Audio levels can be adjusted with the front panel audio pots (Input and Output). Start with the Input levels and feed the unit with normal program audio. Adjust the input until the input audio presence LED flashes with about 50-70% duty cycle with the incoming audio; it can flash more if the audio is densely processed. Output audio should be adjusted for desirable levels into your program path. If the red "Out Clip" LED is illuminating at all, you are getting within 4dB of clipping on peaks. If this same LED is not lighting, but your audio out is distorted, you are probably driving the input too hot. Check for a flashing "Input Clip" LED and set the input gain control for the maximum gain that does NOT cause the input clip LED to flash.

Filters.

All adjustments to the encoder assume 25 and 35 Hz signal encoding. The process for setting 50 and 75 Hz encoding is identical, except, of course for the frequencies and one jumper. When setting up for 50/75Hz operation, it is assumed that you will still want to encode 25 & 35 Hz, so compromise frequencies of 29.5Hz and 62.5 Hz have been selected to give roughly equal attenuation at 25, 35, 50 & 75Hz. Note, however that the maximum attenuation at any one frequency achievable using only the two internal notch filters is about 17dB, which may not be acceptable if your program material contains significant amounts of music or other subaudible content. If you are planning to use the 50/75Hz options, we suggest leaving the two low frequency filters set and use an external EQ before the SEN-6 to roll off audio below 100Hz.   The filter sections are tuned at the factory with standard reference tones and should not need further adjustment by the user. However, if the need unexpectedly arises to tune these circuit sections you will need a scope or analog audio level meter that has good display characteristics at low audio frequencies, a signal generator or known accurate 25Hz and 35Hz signal source, and an accurate frequency counter if your signal source is a continuously adjustable device (most are). The frequency counter can be left hung across the signal source for fine tuning the frequency of the signals being fed during the alignment process. The audio level of the tone source should be between -10 and +8 dBm. If the signal is unbalanced, be sure to tie ring and sleeve on the input connector to the unbalanced source's shield.

To Tune the filter sections set the generator or signal source for the operating frequency of the filter being tuned and adjust the associated multiturn pot for minimum audio (the null point) at the main output. A properly tuned filter will attenuate the notch frequency by 40dB or more. R16 adjusts the low frequency and R26 adjusts the upper frequency. If R26 is adjusted for 63 or 75 Hz, J9 should be removed to match the gain through that stage.

J3 and J4 set which filters will be on-line. You can select low only, high only or both. If you are only using one tone, greater low frequency response and less low frequency phase shift can be obtained by using only the filter for the desired frequency. However, removing one filter from the circuit inverts the output phase, so care should be taken to avoid out of phase mixing downstream.

High frequency filter gain set.

High Frequency notch filter adjust

J3 & J4 - Filter select
Key:
J3 1&2 & J4 2&3 = both filters in
J4 1&2 = low filter only
J3 2&3 & J4 2&3 = high filter only

Low Frequency notch filter adjust

REPAIR OR SERVICE INFORMATION

In the event of the need for service or repair, call CircuitWerkes at (352) 335-6555 for a Return Merchandise Authorization number (RMA). Then carefully package the unit along with a note of the problem and send it to the address below. Clearly indicate the RMA number on the outside of the box. We cannot accept returns without an RMA. Be sure to include your address (not a PO box), telephone number and best time to call.

CircuitWerkes

ATTN: CUSTOMER SERVICE DEPT.
3716 SW 3rd Place
GAINESVILLE, FL 32607

CircuitWerkes Limited Warranty

This product is warranted against defects for two years from date of purchase from CircuitWerkes and CircuitWerkes authorized distributors. Within this period, we will repair it without charge for parts and labor. Proof of purchase-date required. **Warranty does not cover transportation costs, or a product subjected to misuse, accidental damage, alteration (except as authorized by CircuitWerkes), improper installation, or consequential damages.**
Except as provided herein, CircuitWerkes makes no warranties, express or implied, including warranties of merchantability and fitness for a particular purpose. Some states do not permit limitation or exclusion of implied warranties; therefore, the aforesaid limitation(s) or exclusion(s) may not apply to the purchaser. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

Note: Although every effort is made to make our technical materials complete and accurate, manuals are frequently updated in order to improve them. All specifcations and information contained herein is subject to change without notice. The latest version of this manual is available online at the CircuitWerkes internet web site. The address is: http://www.circuitwerkes.com/ E-mail may be sent to info@circuitwerkes.com.