SubAudible
Tone Decoder
Model Sub-03b
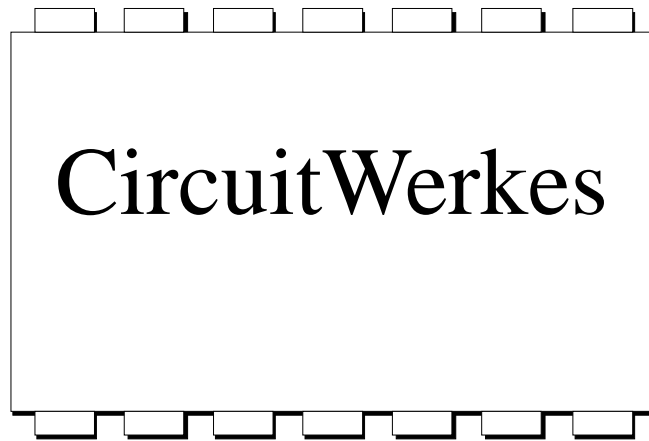
CircuitWerkes

Technical Manual

Notes:

The CircuitWerkes Subaudible Tone Decoder

Description

The CircuitWerkes Subaudible Tone Decoder provides a reliable and accurate solution for decoding subaudible tones from satellite, automation, or other sources of audio. The unit has dry relay contacts and an LED indicator for each of the standard three subaudible signals, 25HZ, 35Hz and the Combination of 25HZ and 35Hz. Alternately, the Sub-03b may be ordered set for 50/75Hz tones. The audio input can accept balanced or unbalanced audio at input levels of -20dBm to +8dBm. The output is balanced transformerless and is easily capable of driving a 600 ohm load. Subaudible tones are typically attenuated by 30dB at the audio output and it is short-circuit protected.

Installation & Setup

CONNECTIONS:

Connections to the Subaudible Tone decoder are fairly straight forward. Your audio passes through the decoder via the Audio In and Audio Out jacks. The audio input jack has jumper J-3 associated with it. J-3 provides a convenient way to unground the input audio sleave if desired. When the input is unbalanced, the (-) input lead must be tied to ground. Relay outputs and the power input are brought out to both barrier strips and a Db-9 connector. All relay outputs are seperate and operate whenever their specific tone is detected. Two additional barrier strip positions are for the relay disable function. These inputs are active if Jumer J4 is removed. When J4 is removed and there is nothing connected between the disable inputs, the decoder will not output any closures. This is useful if you want your automation or other external timer to activate the decoder only at certain times of the day. If J4 is removed, the Sub-03b <u>must have a connection between these two positions for it to output contact closures</u>. J4 simply parallels the external input connector. If J4 is on (the default) the Sub-03b relays will operate whenever a tone is detected. Finally, in addition to the terminal and Db-9 locations, the power input may be also be made to a 2.5mm coaxial (or "barrel") 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 Sub-03b. See page 3 for connection details. Power is provided by the included "wall-wart." Optionally, the decoder cam be powered with any supply of 18-24 Volts AC or DC capable of delivering 150mA. The relay outputs are dry N.O. contacts capable of switching loads up to 10 watts. We recommend slave relays if you intend to switch heavy loads or high voltages.
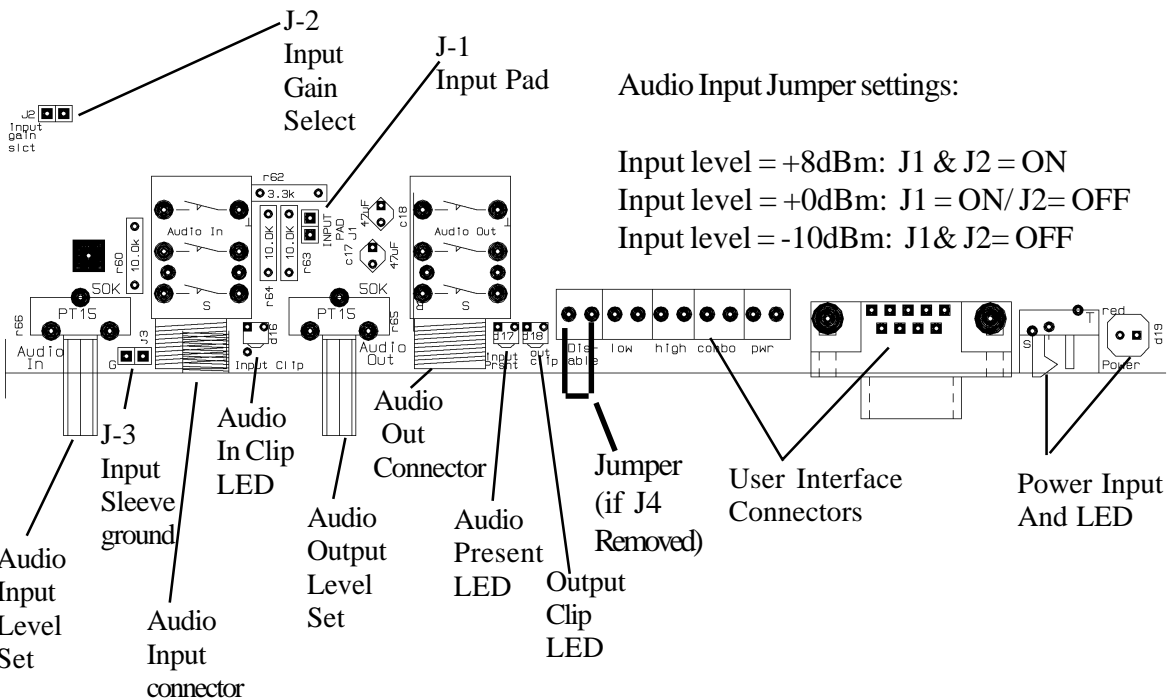
Important Note regarding program content...

If your subaudible tone decoder is connected to a source that delivers more than one program and one or more of the programs delivered does not contain subaudible tone signalling you may encounter (easily resolved) problems. Any program that does NOT contain subaudible signalling tones probably DOES have subaudible content. Normal music/voice and background noise can easily set off your decoder's outputs if the audio is not (high pass) filtered. Programs that do contain subaudible signalling tones will always be prefiltered at their origination point before subaudible tones are injected, thus keeping the natural low frequency content of normal voice and noise from false tripping decoders down the line.

A good example would be an SCPC satellite receiver that you use for a couple of different network feeds. One of the networks uses subaudible tone signalling for starting local breaks, the other uses DTMF Tones. The network that uses DTMF tones probably does not filter out the subaudible portion of their program audio. If you have a limited number of inputs on your console or automation system, you may not wish to take up two inputs with audio from one source. To help solve this problem, the CircuitWerkes Subaudible Tone Decoder features a disable input. Removing J4 and connecting this line to the decoder's ground will enable the relays. You may connect this line and the decoder's ground to a timed automation output that will sink to ground only during the program whose tones you want to use. Any other time, the automation would unsink the disable input and the tones will not cause relay closures. *<u>If you remove J4 & decide not to use the disable function, a wire jumper must be installed between the two screw terminals to enable the decoder.</u>*

SETTING LEVELS:

The Sub-03b can accept a wide variety of input levels and its improved output driver can supply peak levels of up to +18dBm into a 600 Ohm load. There are 2 jumpers associated with the input audio levels. If your audio input is at +8 or more, both J1 and J2 should be on. If your input is at 0dBm, only J1 needs to be set. If the audio input level is -10dBm or less, then both jumpers should be off. Whichever jumper setting you choose should allow the maximum amount of input audio WITHOUT lighting the input clipping LED. The Sub-03b has a maximum dynamic range of about 90dB. By selecting the highest input level that does not cause clipping of the input stage, you are geting the maximum signal to noise ratio from the Sub-03b. Since satellite programming is pre-limited, you may be able to use more aggressive input jumper settings to maximize audio throughput. This is fine as long as the input clipping LED stays off. After setting the input jumpers, adjust the input level control pot on program material until the Input Presence LED is lit 50-70% of the time. This is the correct level range for the tone detectors to work. Finally, adjust the output level control for the level that you want. This control is variable from 0 to about +18dBm. Be sure that the output clipping indicator does not light, or you will have a distorted output.

Sub-03b Connector & Controls Layout (Top View)

Audio Input Jumper settings:

Input level = +8dBm: J1 & J2 = ON
Input level = +0dBm: J1 = ON/ J2= OFF
Input level = -10dBm: J1& J2= OFF

Note: The front panel of the Sub-03 contains a bi-colored LED for indicating 25/35 Hz detection and a single LED for indicating the combination tone.

Sub-03a Db-9 as seen looking at front of device.

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

           9      8      7      6
           O      O      O      O
```
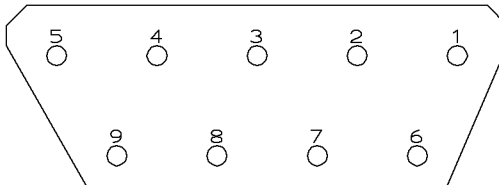
LEGEND:
1 & 6 = Disable Input. Remove J4 and short to enable relays.
3 & 7 = Low Tone Relay Output
4 & 8 = High Tone Relay Output
5 & 9 = Combo Tone Relay Output

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

CircuitWerkes
Sub-3 Subaudible Tone Decoder
Audio In/Out Wiring

Input

1/4" TRS (phone) PLUG

```
              TIP
SLEEVE  RING
```
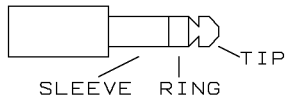
Tip is Balanced (or Unbalanced) + In

Ring is Balanced - in.

Sleeve is audio ground and should be connected
to your source's ground.

If your input is unbalanced
you must tie ring and
sleeve together for
proper operation.

Output

1/4" TRS (phone) PLUG

```
              TIP
SLEEVE  RING
```
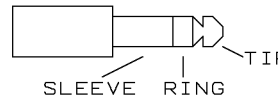
Tip is Balanced Out +.

Ring is Blanced Out -.

Sleeve is left floating and may be tied to
ground on the other end.

Do NOT Connect minus (-)
Output to Ground!

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SUB-3b PC Board Layout

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(352) 335-6555 / e-mail: info@circuitwerkes.com

Jumpers J1/J2 control Input gain range
Jumper J3 ungrounds Input audio sleave when off

Diodes d1-4 & 10-12 are 1N4148 or eqv.
Q1-3 are PN 2222 or equiv

Updated manuals & info are available
via Internet at www.circuitwerkes.com
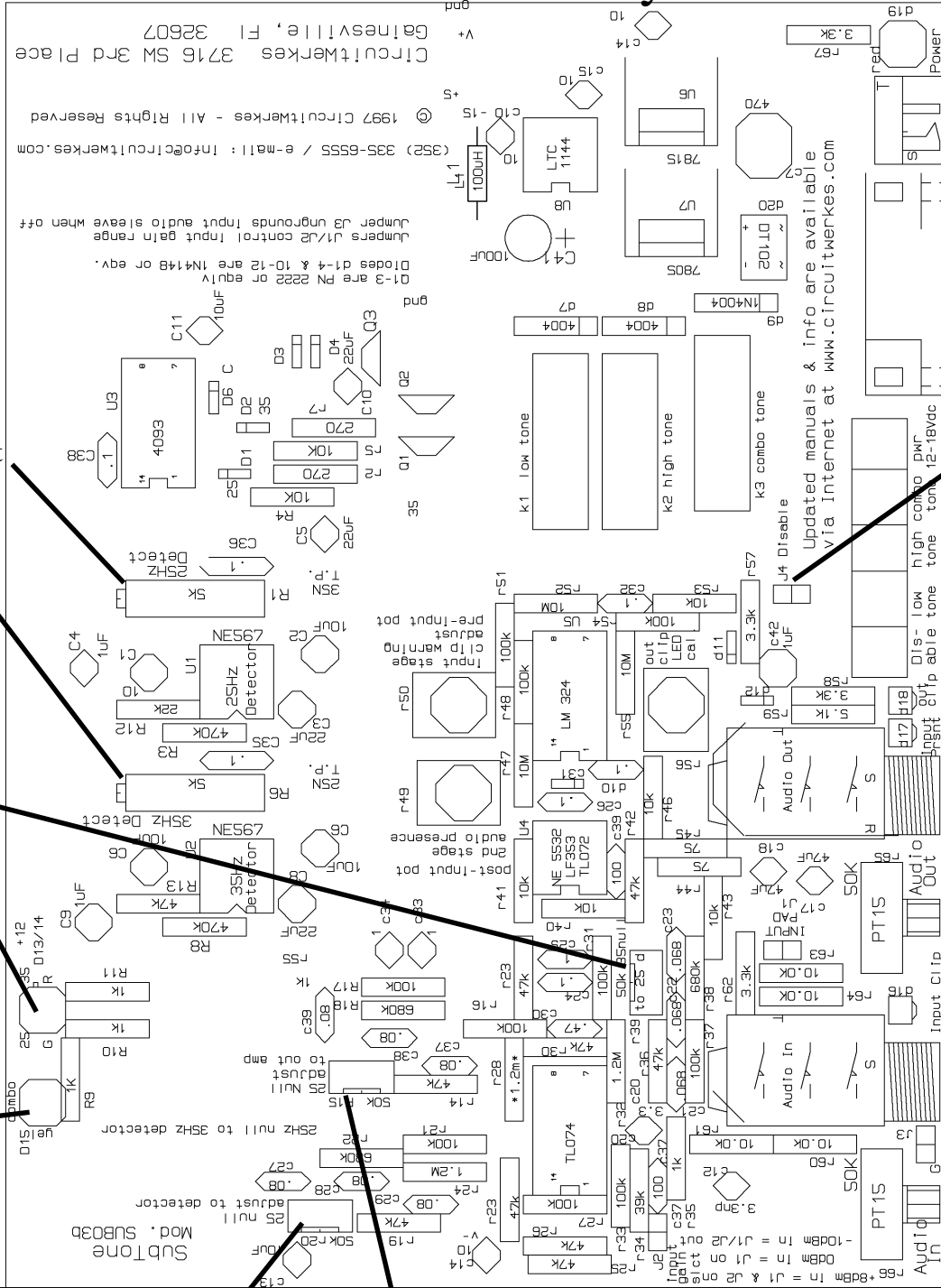
25 Hz Detect Calibration

35 Hz Detect Calibration

35Hz Null adjust

Low (red) & High (green)Tone Detection LED

Combo Tone Detection LED

Main 25Hz Null adjust (to detector)

Secondary 25Hz Null adjust (to audio output)

J4 Remove to disable/ activate ext. Disable

SubTone Mod. SUB03b

Input gain slct
-10dBm In = J1/J2 off
0dBm In = J1 on
+8dBm In = J1 & J2 on

Sub-3 Subaudible Tone Decoder Schematic

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Subtone decoder '97

High Freq. Filter Section

R25 47k
R20 100k
R21 680k
R22 100k
U9B TL074
C16 .068uF
C17 .068uF
C18 .068uF
.068uF vert adj.
R24 50k m/t
R36 47k
R26 1.2m
35 or 75 Hz filter

Low Freq. Detector

VCC
hash filter
C33 1uF
35Hz Null Output
U1 NE567
IN OUT FLTR
R C BW
R12 47k
D1 1N914
R2 270
VCC
U3A 4093
On Delay
R4 10k
C5 22uF
Q1 2N4401
R3 470k
C4 1uF
C3 22uF
C2 10uF
R1 5k m/t
vert top adj.
C1 10uF

after filter adj.
level at U9 pin 8 should
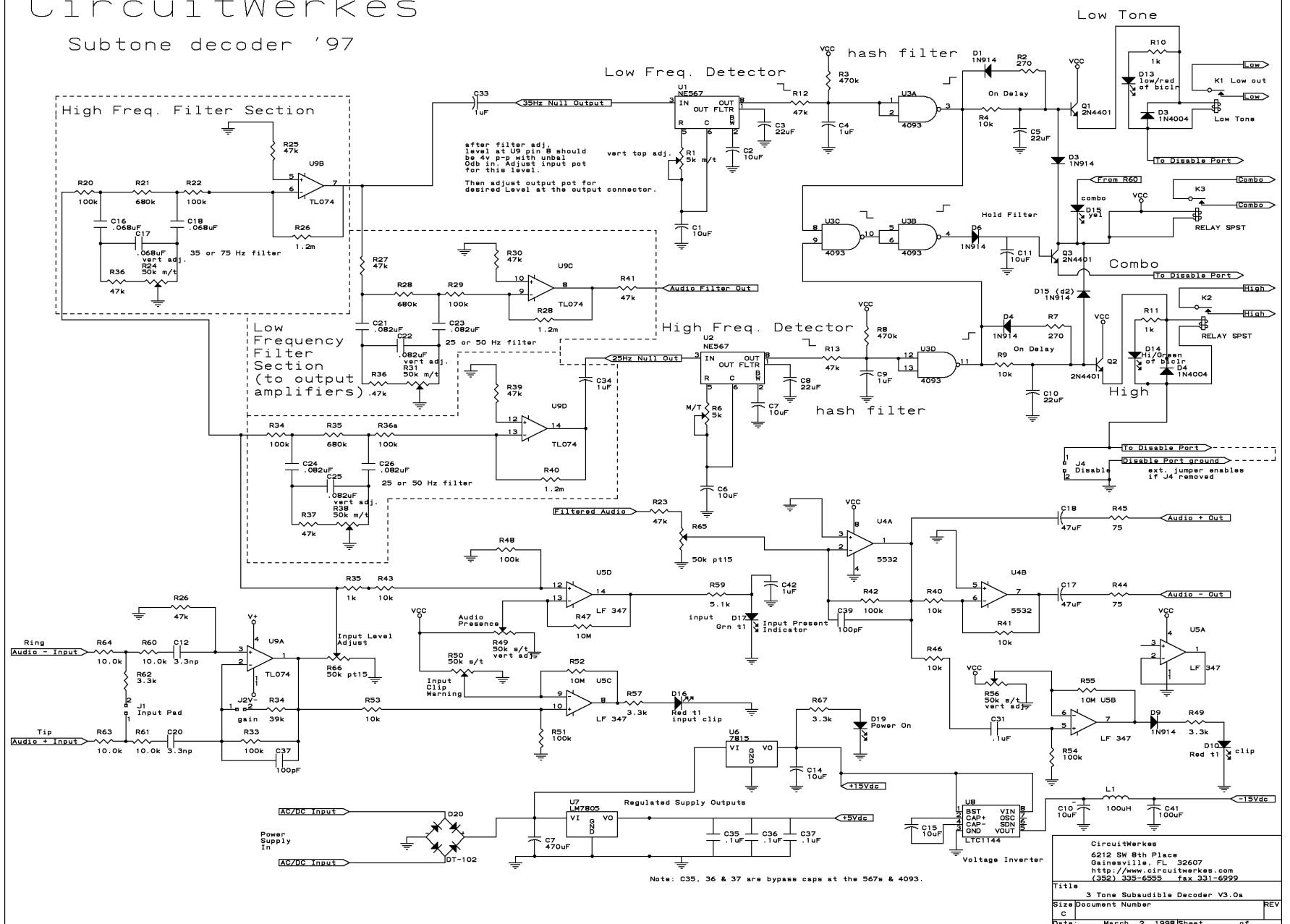be 4v p-p with unbal
0db in; Adjust input pot
for this level.

Then adjust output pot for
desired Level at the output connector.

Low Tone
R10 1k
D13 low/red of biclr
K1 Low out
Low
Low
D3 1N4004
Low Tone
To Disable Port

Low Frequency Filter Section (to output amplifiers)

R27 47k
R28 680k
R29 100k
U9C TL074
R41 47k
R30 47k
C21 .082uF
C22 .082uF
C23 .082uF
.082uF vert adj.
R31 50k m/t
R28 1.2m
25 or 50 Hz filter
R36 50k m/t
R36 47k
Audio Filter Out

From R60
combo
D15 yel
VCC
K3
Combo
Combo
RELAY SPST
Hold Filter
U3C 4093
U3B 4093
D6 1N914
C11 10uF
Q3 2N4401
Combo
To Disable Port
D15 (d2) 1N914

High Freq. Detector

R34 100k
R35 680k
R36a 100k
U9D TL074
R39 47k
C24 .082uF
C25 .082uF
C26 .082uF
.082uF vert adj.
R38 50k m/t
R37 50k m/t
R37 47k
R40 1.2m
25 or 50 Hz filter
C34 1uF
25Hz Null Out
U2 NE567
IN OUT FLTR
R C BW
M/T R6 5k
C7 10uF
C6 10uF
hash filter
R13 47k
VCC
R8 470k
C9 1uF
C8 22uF
U3D 4093
On Delay
R9 10k
C10 22uF
Q2 2N4401
D4 1N914
R7 270
VCC
D14 Hi/Green of biclr
R11 1k
K2
RELAY SPST
High
High
D4 1N4004
High
To Disable Port
Disable Port ground
J4 Disable
ext. jumper enables
if J4 removed

Filtered Audio
R23 47k
R65 50k pt15
VCC
U4A 5532
C18 47uF
R45 75
Audio + Out
R48 100k
U5D LF 347
R47 10M
C42 1uF
R59 5.1k
input
D17 Grn t1
Input Present Indicator
R42 100k
U4B 5532
R40 10k
R41 10k
C17 47uF
R44 75
Audio - Out
C39 100pF
R46 10k
VCC

R26 47k
V+ U9A TL074
Ring
Audio - Input
R64 10.0k
R60 10.0k
C12 3.3np
R62 3.3k
J1 Input Pad
Input Level Adjust
R66 50k pt15
R35 1k
R43 10k
Audio Presence
R49 50k s/t vert adj
R50 50k s/t
Input Clip Warning
R52 10M
U5C LF 347
R57 3.3k
D16 Red t1 input clip
R51 100k
R67 3.3k
D19 Power On
VCC
R56 50k s/t vert adj
C31 .1uF
R54 100k
R55 10M U5B LF 347
U5A LF 347
D9 1N914
R49 3.3k
D10 Red t1 clip

Tip
Audio + Input
R63 10.0k
R61 10.0k
C20 3.3np
J2 p2
R34 39k
gain
R33 100k
C37 100pF
R53 10k
U6 7815
VI VO GND
C14 10uF
+15Vdc

U8
BST VIN
CAP+ OSC
CAP- SDN
GND VOUT
LTC1144
Voltage Inverter
C10 10uF
L1 100uH
C41 100uF
-15Vdc

AC/DC Input
D20
Power Supply In
AC/DC Input
DT-102
U7 LM7805
VI VO GND
C7 470uF
Regulated Supply Outputs
C35 .1uF
C36 .1uF
C37 .1uF
+5Vdc
C15 10uF

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

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CircuitWerkes
Subaudible Tone Decoder
Block Diagram

Audio IN → INput AMP w/level ctrl → Audio Present Indicator

35 Hz Notch → 25Hz Detector → hash filter → 25Hz Relay output

25Hz Notch → Output Amp → Audio Out

Output Clip Indicator

Combo Detect Logic → 25/35 Combo Relay Output

hash filter → 35Hz Relay output

25 Hz Notch → 35Hz Detector

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Theory of Operation

Incoming audio is buffered and level controlled by U9a and its associated components. Three nodes are fed by this first buffer section, the audio input clipping indicator, the input audio presence indicator (U6b), the 35Hz notch section (U9b) and the main 25Hz notch section, U9d.

The audio input clipping and presence indicators are basically identical except that the clipping indicator is driven directly from the first buffer's output and is set to a level just below the point where the input buffer overloads. The audio present indicator is fed from just after the input gain control pot and is comprised of opamp U6b (operated as a comparator), reference-set pot R53, a yellow LED and associated components. When the audio level exceeds the preset comparator reference level, the comparator changes states and illuminated the LED. The reference level pot is set to illuminate the LED when detection amplitude is ideal.

The 35Hz notch section is a modified twin-tee circuit, the exact center frequency of which is set by multiturn pot R24. Buffer U9b feeds the 25 Hz detector section and a secondary 25Hz notch filter, U9c, (of the same design) which in turn feeds the balanced output amps comprised of U5 and its associated components. Another comparator-LED circuit hangs off the end of the output amp and is set to illuminate when the audio output level approaches clipping.

The main 25Hz filter section feeds the 35Hz detector section while the 35Hz filter feed the 25Hz detector. It is necessary to remove the opposite frequency tones from the audio feeding each detector. The outputs of the two detector sections feed through hash filters (to eliminate any extraneous falsing). The hash filters are simple RC constants on Schmitt trigger inputs of U3a (25Hz detector) and U3d (35Hz detector). The outputs of the hash filters feed an AND gate (comprised of U3c and U3b) directly and the relay driver circuits for their respective relays through an RC delay filter. If both tones are detected simultaneously, the AND gate circuit fires the combo tone relay and defeats the relay drivers of the individual tone outputs. If only a single tone is detected, its relay output folows after a brief delay.

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 console or automation. 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 jumpers for the maximum gain that does NOT cause the input clip LED to flash.

Filters and Detectors.

All adjustments to the decoder assume 25 and 35 Hz signal decodeing. The process for setting 50 and 75 Hz decoding is identical, except, of course for the frequencies. 50Hz is substituted for 25Hz and 75Hz subs for 35Hz. The filter sections and detectors 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, depending upon jumper settings. 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 test point for the filter you are adjusting. The two main tone test points are square pads on the PC Board near variable resistors r1 and r6. They are labelled 25N T.P. and 35N T.P. Adjust R20 to null 25Hz. Adjust R39 to null 35Hz

Secondary 25Hz - adjust R15 - test point is the main audio output.

The detectors should not be aligned unless the filter sections have been aligned first.
The detector alignment process is the same for both detectors. First set the signal source for the operating frequency of the detector you will be tuning, then find the turn-on point of the detector in each direction of rotation of the multiturn detector's alignment pot. Set the pot for half way between thee two points.
R1 is the 25Hz detector adjustment; R6 is the 35Hz detector adjustment. To find the center of the detector's range, reduce the input gain until the detector just barely operates. Very slowly adjust the multiturn pot about a turn in each direction noting where the center of the turn on range is. Set the pot to the center of the range and you're done. Note that there is hysteresis in the individual detection outputs to allow the combo tone logic a chance to operate. That means that you must adjust the detection circuit extremely slowly in order to get an accurate idea of the center range.

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.**

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Note: Manuals are frequently updated in order to improve them. 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.