ELECTRONOTES
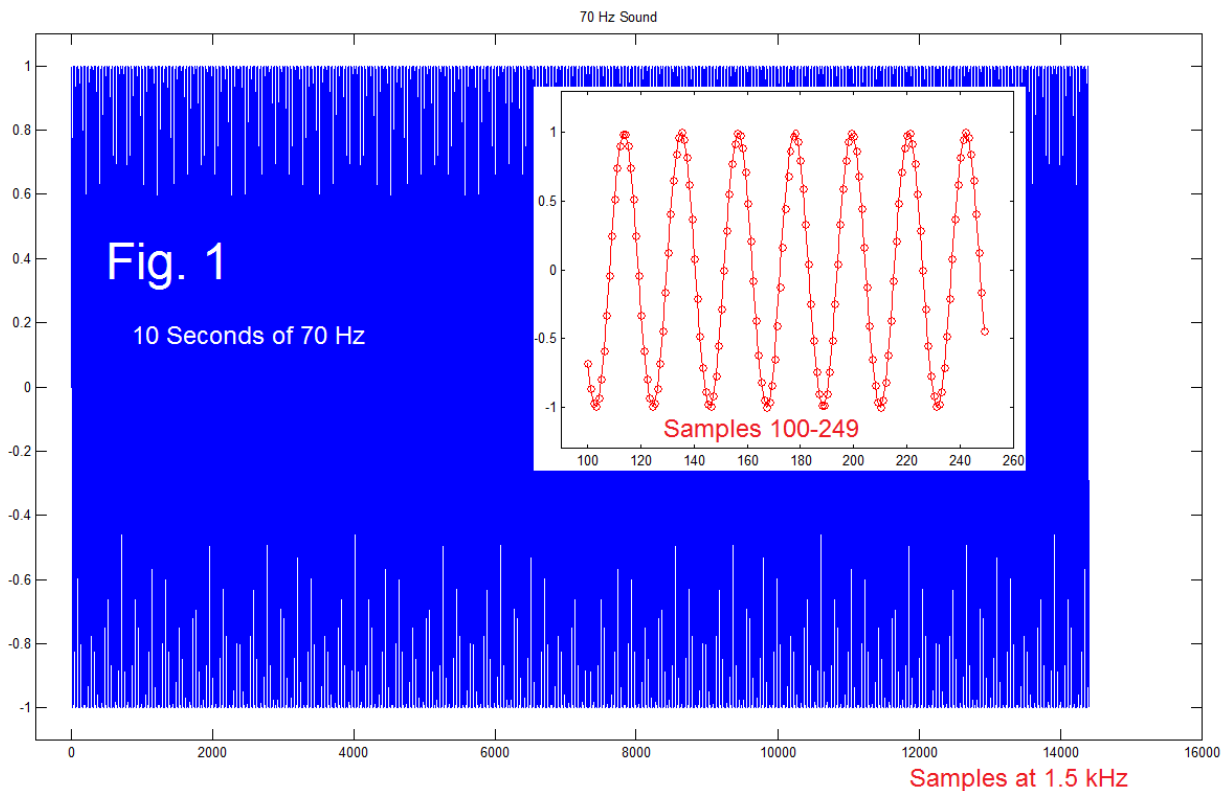
ENWN-46

INTERRUPTION OF THE HUM – AUDIO SIMULATIONS

     Previously [1] we reviewed numerous comments/reports on "the Hum" phenomenon. The view is offered that a personal ability to "interrupt" the hearing of the Hum briefly (it goes away and returns in about 1/2 second) as a result of a sharp sound

Fig. 1

10 Seconds of 70 Hz

Samples 100-249

Samples at 1.5 kHz

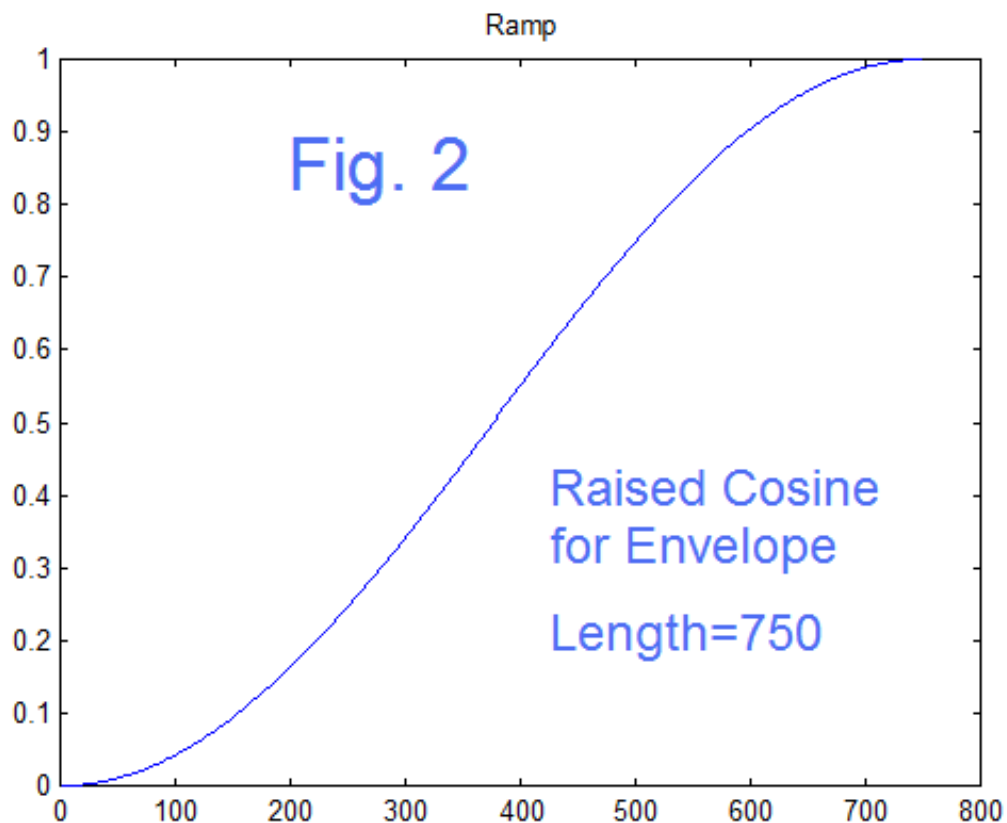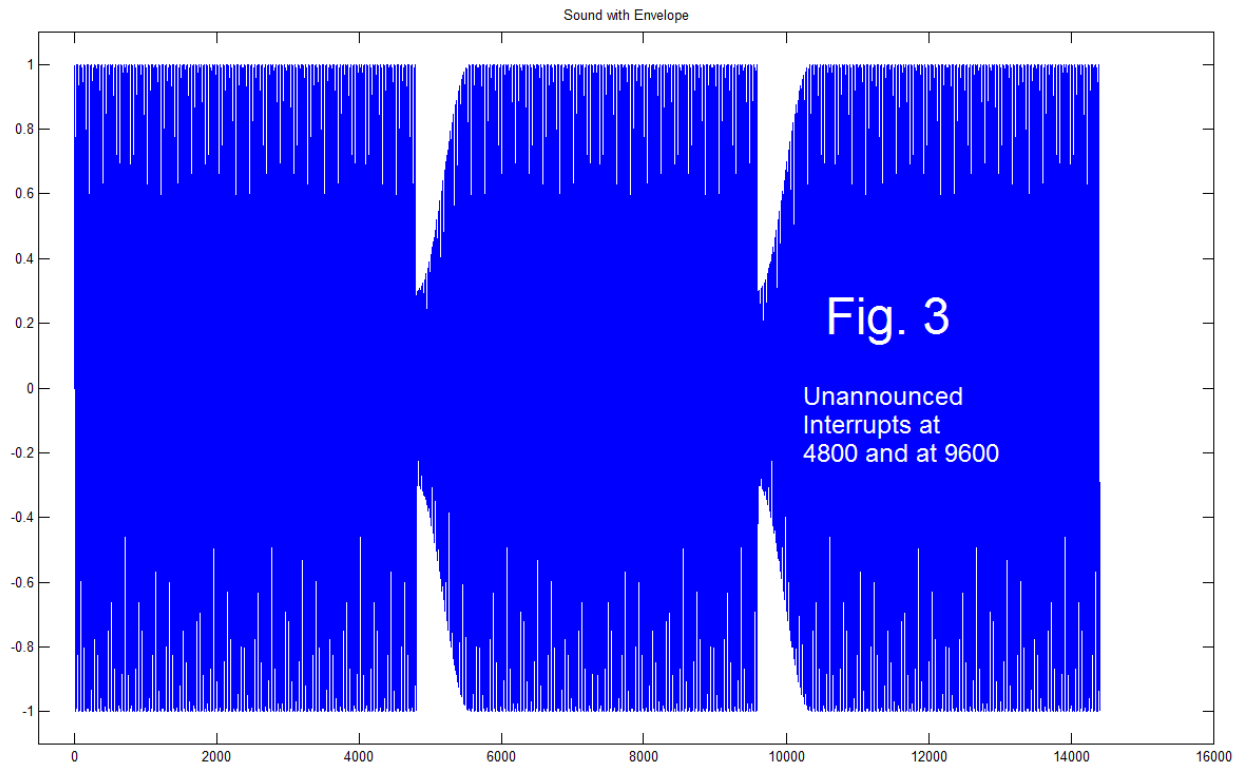http://electronotes.netfirms.com/interrupt0.WMA

or head-shake is diagnostic of the <u>standard</u> Hum and <u>perhaps</u> indicative of the origin. This interruption is not exceptionally easy to detect perceptually.   Accordingly we offered an example (simulated) audio of the interruption on Glen's website.   Here this note has three main purposes: (1) to offer a link to three different examples, (2) to have these links directly below a plot of the entire example, and (3) to give the complete "as-is" Matlab code of the examples.
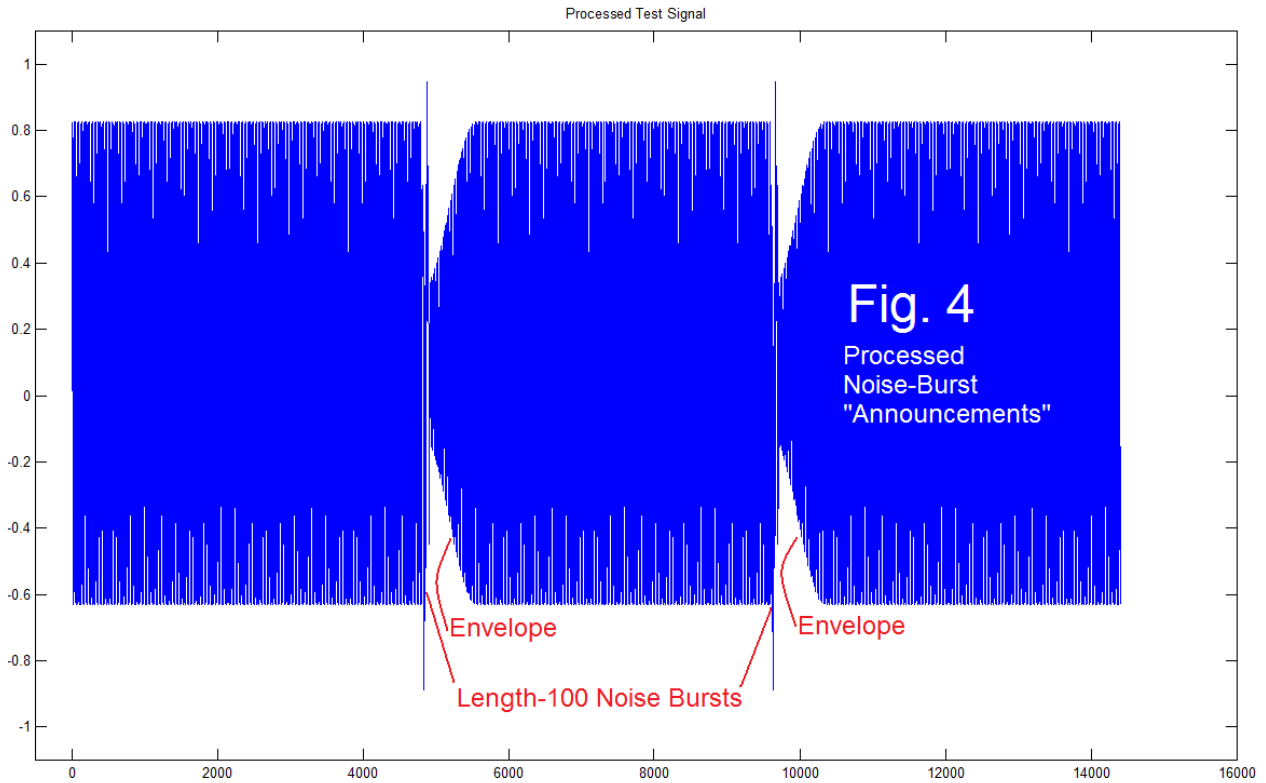
Fig. 1 shows the reference plot of a 70 Hz sinusoidal.   Many "Hum hearers" hear a pitch more like 50 to 65 Hz.   Here 70 Hz was chosen to give a useful impression of the <u>low nature of the pitch</u> without excessively degrading the sound quality due to low-frequency limits on the Internet. The link just below Fig. 1 gives a 10 second uninterrupted example.   In order to identify the start of the 10 seconds, a brief (200 samples) burst of a 750 Hz tone (thus about 0.133 sec.), "beep" begins each example. Because there are so many cycles (700) in 10 second, the "plot" looks mostly like a blue rectangle. The inset shows 150 samples in detail (7 cycles in 150/1500 sec.).

In order to implement an interruption, an "envelope" that multiplies the uninterrupted tone is formed. This was first done with a linear ramp and then an exponential ramp. We later settled for a raised cosine (Fig. 2).   This ramps up from 0 to 1 over 1/2 second (750 samples) and allowed the starting point to vary. The examples here actually run from 0.3 to 1.0, the shape being a compressed version of Fig. 2.

Ramp

Fig. 2

Raised Cosine
for Envelope

Length=750

Sound with Envelope

Fig. 3

Unannounced
Interrupts at
4800 and at 9600

Processed Test Signal

Fig. 4

Processed
Noise-Burst
"Announcements"

Envelope

Envelope

Length-100 Noise Bursts

The example of Fig. 3 (and audio link below) gives the case where two interruptions are added to the uninterrupted tone. One occurs at 4800 samples (about 3 seconds after the beep) and the other at 9600 samples (about 6 seconds after the beep). These we call "unannounced" as the level drops down and returns over 1/2 seconds, but we are given no warning, or apparent cause of the drop. It <u>sounds as it would</u> if we had given our head a vigorous shake just before 3 seconds (6 seconds) and stopped. Most assuredly, if we had shaken our head the initiation would be known to us and be part of the overall perception.

The third example, Fig. 4 (and audio link below), is the same as Fig. 3 except an "announcement" consisting of a noisy burst occurs just before eacn of the two interruptions. This is a substitute for the sharp sound or "grunt" previously suggested. As positioned, it seems to be the cause of the interruption. It is a bit filtered and is short (100 samples or 0.067 sec) so was intended not to unduly distract.

The examples are not intended to simulate the Hum itself. Instead they suggest in general the low pitch of the Hum, and with more specificity, what the temporal aspects of interruptions actually sound like.

REFERENCES

[1]   B. Hutchins, "Current View of My View of 'The Hum' ", Electronotes Webnote 40, 5/6/2016   http://electronotes.netfirms.com/ENWN40.pdf

[2] B. Hutchins, "Brief Interruptions of 'the Hum' ", Electronotes Webnote 41, 6/18/2016 http://electronotes.netfirms.com/ENWN41.pdf

[3] B. Hutchins, "Interruption of the Hum – Speculation", Electronotes Webnote 43, 9/28/2016   http://electronotes.netfirms.com/ENWN43.pdf

PROGRAM (as is)

```
n=0:14399;
F=70
fs=1500
s=sin(2*pi*F*n/fs);
beep=cos(pi*[0:199]);
 sound([beep s],fs)
pause

figure(2)
plot(s)
axis([-500 16000 -1.1 1.1])
title('70 Hz Sound')
figure(6)
plot([100:249],s(100:249),'or')
hold on
plot([100:249],s(100:249),'-r')
hold off
axis([90 260 -1.3 1.3])

rampdursec=0.50
rampdurn=rampdursec*fs
nn=0:(rampdurn-1);
ramp=(1/2)*(1-cos(pi*nn/rampdurn));
figure(1)
plot(ramp)
title('Ramp')

e=[ones(1,4800) ramp ones(1,(1600-rampdurn)) ones(1,3200) ramp ones(1,(1600-
rampdurn)) ones(1,3200)];
e=0.3+0.7*e;
length(e)
figure(3)
plot(e)
axis([-500 16000 -1.1 1.1])
title('Envelope')
se=s.*e;
figure(4)
plot(se)
axis([-500 16000 -1.1 1.1])
title('Sound with Envelope')
sound([beep se],fs)
pause

intdurn=100;

int2=2*(rand(1,intdurn)-0.5);   %random burst "grunt"
int2=filter((5)*ones(1,5),1,int2);   % filter burst a bit
```

```
% form overall envelope
int=[ones(1,4800) int2 ones(1,(1600-intdurn)) ones(1,3200) int2 ones(1,(1600-
intdurn)) ones(1,3200)];
length(int)

sei=0.89*se+0.1*int;   %add bursts
seif=filter((0.14)*ones(1,7),1,sei);   % filter a bit
sound([beep,seif],fs)
figure(5)

plot(seif)
axis([-500 16000 -1.1 1.1])

title('Processed Test Signal')
pause
wavwrite(0.5*[beep s],1500,'c:\en-site\interrupt0.wav')
wavwrite(0.5*[beep se],1500,'c:\en-site\interrupte.wav')
wavwrite(0.5*[beep seif],1500,'c:\en-site\interrupts.wav')
```