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IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS.

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Recent developments in pop music studio control rooms have concentrated on producing high sound levels in conditions which have become more and more detached from what is considered to be a normal sound reproduction environment.

The result is a situation where many so called top studios rely on smaller speaker systems mounted in the 'nearfield' position in order to satisfy critical record producers. It is the purpose of this paper to present an evaluation of the low frequency performance of several rooms and provide an indication of possible criteria for good design practice.

Room A

A small control room with minimal low frequency absorption to the sides or rear but with a high ceiling.

Fig. 1.
Shows an ETC (energy plotted against time) for frequencies up to 500Hz. As with all TDS measurements the original sweep is linear using a narrow, fixed bandwidth filter to track the sweep at the same rate. This form of measurement tends to reduce the significance of lower frequencies in the presence of higher ones and therefore small frequency ranges must be used.

It can be seen that the direct sound (0) is followed by 6 discrete reflections at amplitudes only 3-6dB lower than the direct signal. This results in a room decay rate which does not become significant until 50ms has elapsed resulting in smearing and lack of clarity.

The arriving of reflections 1-6 will cause narrow bandwidth cancellations at frequencies whose half wave period corresponds to the time delay between the direct and reflected arrival. These can be clearly seen in Fig. 3.

Fig. 3.
The EFC (energy against frequency) for room A clearly shows destructive interference at frequencies 150Hz, 230Hz and 285Hz on the left and 125Hz, 310Hz and 340Hz on the right.

The significant differences between left and right channels correlates closely with subjective differences between bass musical instruments, even amounting to a noticeable pitch change effect when listening to a drum recording. Equalisation is futile as a means of correcting this type of anomaly although many commercial studios have graphic equalisers attempting just that!

Two solutions were offered to the client, one being to reorientate the monitor system to a nearfield position, approximately 1.5m from the engineers position. The resulting ETC is shown in Fig. 2.

Fig. 2.
It can be seen that the early reflection still exist but that their amplitude has been reduced by an average of 10dB. Although the room still suffers from insufficient low frequency damping the increased direct to reflected energy

ratio considerably improves the EFC as shown in Fig. 4.

Fig. 4.
The nearfield response shows considerable improvement in the low frequency response with greater consistancy between left and right channels. The cancellations between 300Hz and 400Hz are typical of those caused by reflections off the surface of the mixing console in front of the engineer. They can be reduced by creating a console hood, forming an acoustic shadow.

Fig. 5.
Shows the large amount of energy reflected from the rear corner of the room at frequencies below 200Hz. The expanded ETC shows the arrival time of the reflection to be 19.5ms, a distance of 6.73m from main monitors to the mix position via the rear wall.

Fig. 6.
Shows the EFC of a room with subjectively good low frequency response. It can be seen that both channels match well and summing the two channels produces a smooth curve almost 6dB higher in level indicating a high degree of sound field integration.

The large cancellation at 200Hz was found to be caused by the mixing console.

Fig. 7.
By plotting frequency and time against energy contours it is possible to display the overall decay characteristics of the room. The individual reflections in the 250Hz region are accentuated by under damping of the room in the same band. Otherwise there is good correlation between the lowest frequencies and the 400-500Hz region.

Fig. 8.
Displays the EFC of a room which again gives excellent subjective results. The matching of left and right channels is vital to solid stereo imaging and this room is very accurate in this respect.

Fig. 9.
Shows the corresponding ETC showing a significant slurring of the early soundfield but with good damping preventing the effects shown in Fig.1 and 5.

Conclusions

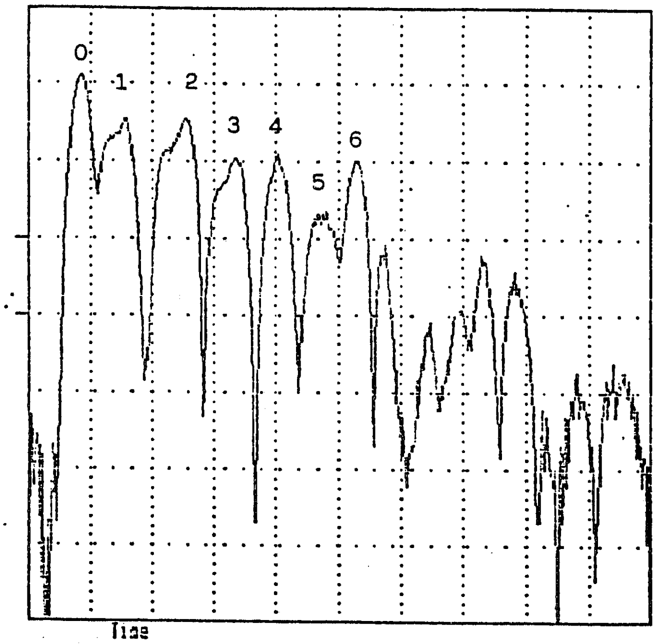
It can be seen that at frequencies below 500Hz early reflections of high amplitude cause deep notch filter 'combing' of the monitor response. The equivalent effects below 150Hz are caused by room reflections which are insufficiently damped.

In subjective terms there is evidence to suggest that some low level interference is desireable, giving a sense of warmth and depth to the scund balance.

Nearfield monitors have obvious advantages in terms of the direct to reflected ratio but great attention must be paid to positioning and orientation.

Fig. 1. Main Monitors. Rocm A.
ETC 0-500Hz

Amplitude ETC
By NICK/MUNRO ASSOC.
On 18.6.86



Vertical: 6dB/div with base of display at -67.0dB
0dB is located at 1 volt

Horizontal: 0 microseconds or 0 Meter to
99525 microseconds or 34.227 Meter
scale: 9.3580E+00 Meter/inch or 3.6843E+00 Meter/cm.
27211 microseconds/inch or 10713 microseconds/cm.

Line Spacing: 249.436 microseconds or 8.57819E-2 Meter
Line Width: 339.234 microseconds or .116663 Meter

Sweep rate: 99.92Hz/Sec

Sweep range: 0.00Hz to 501.13Hz

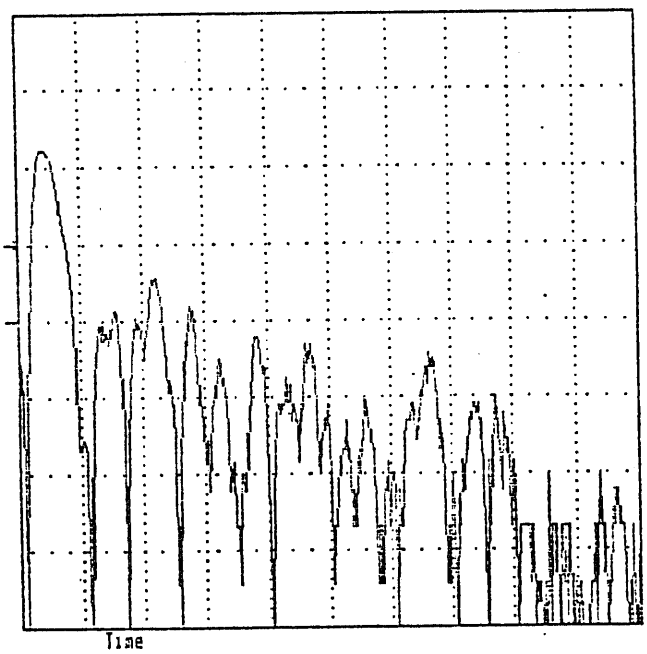
Window file name: A:HAMMING.WST

Input configuration: Channel 1 Non-inverting
with 18dB of input gain & 6dB of IF gain.

IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS

Fig. 2. Nearfield Monitors Room A. 0-500Hz

Amplitude ETC
By HICK/MUNRO ASSOC.
On 18.6.86



Vertical: 6dB/div with base of display at -67.0dB
0dB is located at 1 volt

Horizontal: 0 microseconds or 0 Meter to
99525 microseconds or 34.227 Meter
scale: 9.3580E+00 Meter/inch or 3.6843E+00 Meter/cm.
27211 microseconds/inch or 10713 microseconds/cm.

Line Spacing: 249.436 microseconds or 8.57819E-2 Meter
Line Width: 339.234 microseconds or .116663 Meter

Sweep rate: 99.92Hz/Sec

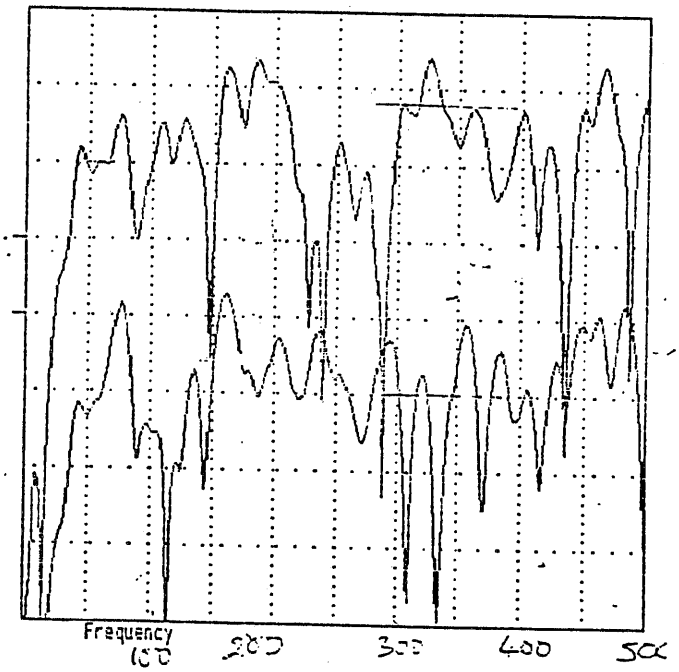
Sweep range: 0.00Hz to 501.13Hz

Window file name: A:HAMMING.WGT

Input configuration: Channel 1 Non-inverting
with 18dB of input gain & 6dB of IF gain.

Fig. 3. Main Monitors Room A.
EFC 0-500Hz

Mag. vs Hz (EFC)
By NICK/MUNRO ASSOC.
On 18.6.86



Vertical: 6dB/div with base of display at -46.0dB
0dB is located at 1 volt

Horizontal: 0.00Hz to 501.13Hz
scale: 137.01Hz/inch or 53.94Hz/cm.

Resolution: 3.4403E+01 Meter & 9.9962E+00Hz

Time of test: 8400 microseconds, 2.8887E+00 Meter

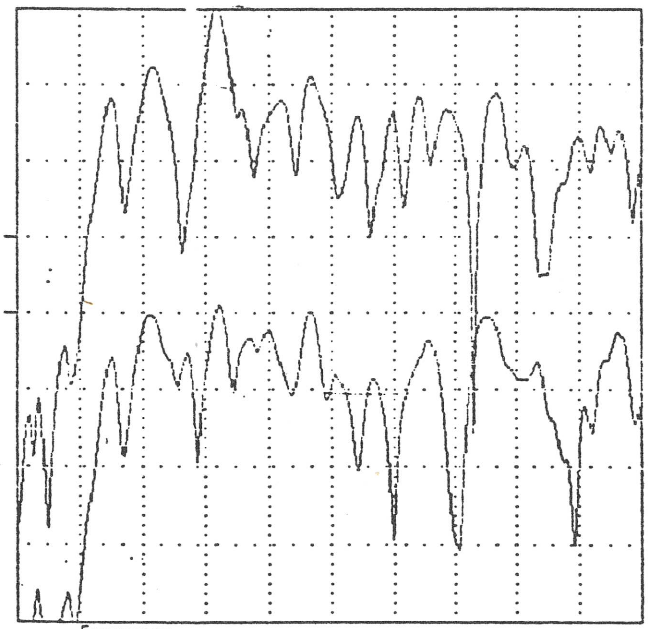
Sweep Rate & Bandwidth: 99.92Hz/Sec & 9.9962E+00Hz

Input configuration: Channel 1 Non-inverting
with 12dB of input gain & 15dB of IF gain.

IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS

Fig. 4. EFC Nearfield Room A. Monitors

Mag. vs Hz (EFC)
By NICK/MUNRO ASSOC.
On 18.6.96



Vertical: 6dB/div with base of display at -40.0dB
0dB is located at 1 volt

Horizontal: 0.00Hz to 501.13Hz
scale: 137.01Hz/inch or 53.94Hz/cm.

Resolution: 3.4403E+01 Meter & 9.9962E+00Hz

Time of test: 8400 microseconds, 2.8987E+00 Meter

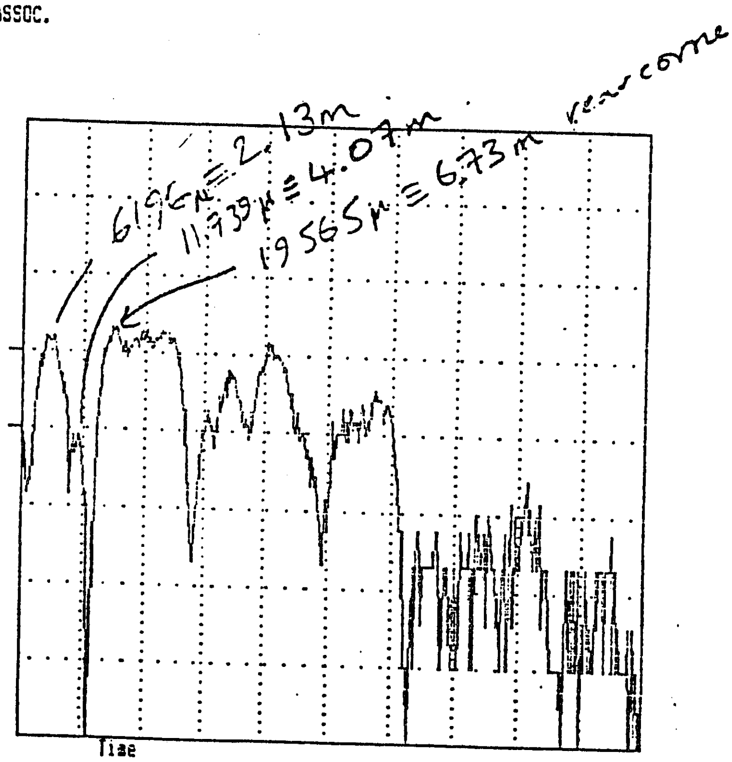
Sweep Rate & Bandwidth: 99.92Hz/Sec & 9.9962E+00Hz

Input configuration: Channel 1 Non-inverting
with 12dB of input gain & 15dB of IF gain.

IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS

Fig. 5. Room A. Expanded ETC
Main Monitors 0-200Hz

Amplitude ETC
By NICK/MUNRO ASSOC.
On 18.6.96



Vertical: 6dB/div with base of display at -67.0dB
0dB is located at 1 volt

Horizontal: 0 microseconds or 0 Meter to
130106 microseconds or 44.7436 Meter
scale: 1.2233E+01 Meter/inch or 4.8163E+00 Meter/cm.
35572 microseconds/inch or 14004 microseconds/cm.

Line Spacing: 326.079 microseconds or .112139 Meter
Line Width: 443.467 microseconds or .15251 Meter

Sweep rate: 19.73Hz/Sec

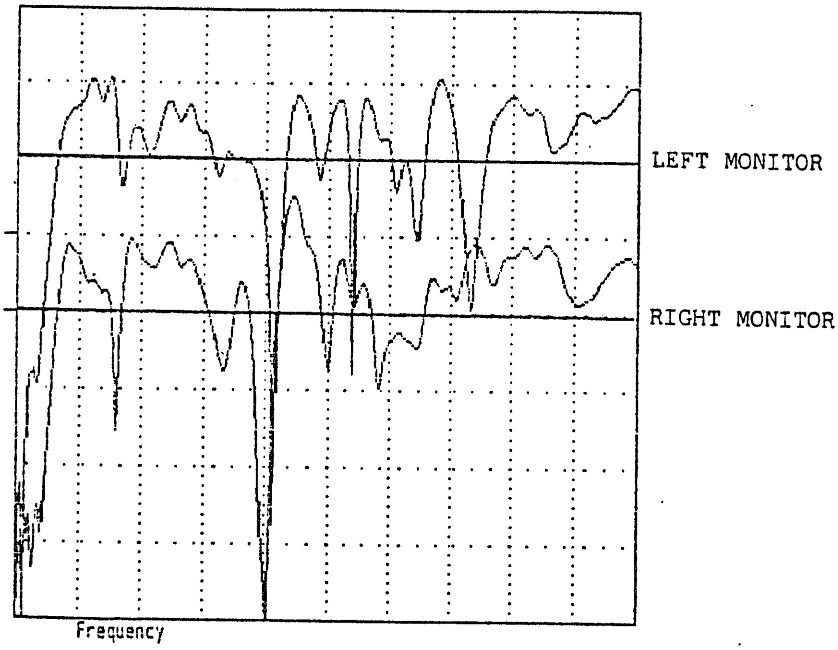
Sweep range: 9.64Hz to 201.31Hz

Window file name: A:HAMMING.W8T

Input configuration: Channel 1 Non-inverting
with 18dB of input gain & 6dB of IF gain.

Fig. 6. Room B. EFC Main Monitors

Mag. vs Hz (EFC) of CONTROL ROOM MONITOR SYSTEM
By
On
At CONTROL ROOM



Vertical: 6dB/div with base of display at -67.0dB
0dB is located at 1 volt

Horizontal: 0.00Hz to 501.13Hz
scale: 137.01Hz/inch or 53.94Hz/cm.

Resolution: 3.4403E+01 Meter & 9.9962E+00Hz

Time of test: 9035 microseconds, 3.1072E+00 Meter

Sweep Rate & Bandwidth: 99.92Hz/Sec & 9.9962E+00Hz

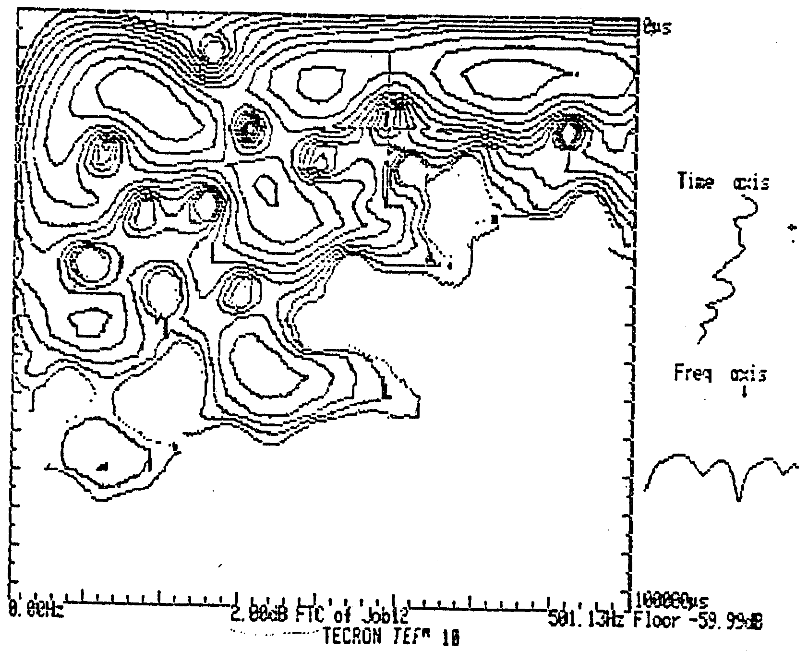
Input configuration: Channel 1 Non-inverting
with 24dB of input gain & 18dB of IF gain.

IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS

Fig. 7. FTC Room B

2.00dB FTC of
By MUNRO/NICK
On 5.2.86

CONTROL ROOM MONITOR SYSTEM



Horizontal

Frequency: 0.00Hz to 501.13Hz
scale: 136.67Hz/inch & 53.81Hz/cm
12.53Hz/tic & 62.64Hz/ticmajor

Vertical

Time:	100000E-6 sec or 34.3903 Meter (bottom)
thru:	0E-6 sec or 0.0000 Meter (top)
scale:	-403E-6 sec or -0.1386 Meter/raster
	-3225E-6 sec or -1.1093 Meter/tic
	-28400E-6 sec or -9.7698 Meter/inch
	-72158E-6 sec or -24.8155 Meter/cm

Resolution: 3.44162 Meter & 9.9925E01Hz

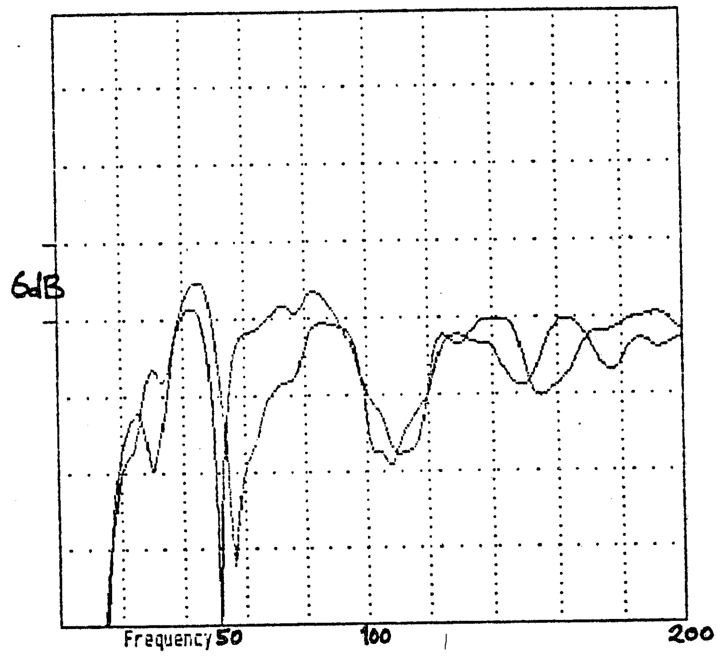
Sweep Rate and Bandwidth: 99.92Hz/sec & 1.00000Hz

Input configuration:
Non-inverting with 24dB of input gain &
18dB of IF gain

IMPROVING THE LOW FREQUENCY PERFORMANCE OF CONTROL ROOMS

Fig. 8. Room C. EFC Main Monitors

Mag. vs Hz (EFC)
By NICK/MUNRO ASSOC.
On 8.7.86



Vertical: 6dB/div with base of display at -58.0dB
0dB is located at 1 volt

Horizontal: 0.00Hz to 201.31Hz
scale: 55.04Hz/inch or 21.67Hz/cm.

Resolution: 7.7418E+01 Meter & 4.4422E+00Hz

Time of test: 8304 microseconds, 2.8556E+00 Meter

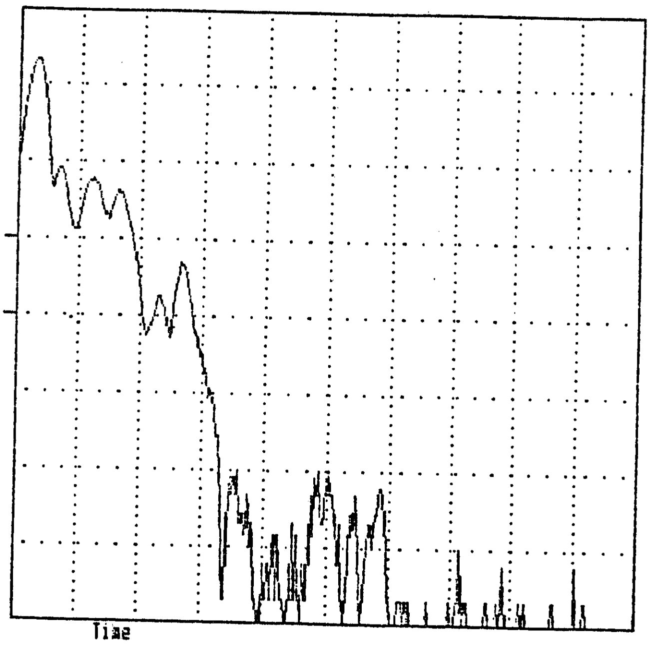
Sweep Rate & Bandwidth: 19.73Hz/Sec & 4.4422E+00Hz

Input configuration: Channel 1 Balanced
with 30dB of input gain & 15dB of IF gain.

8

Fig. 9. ETC Room C

Amplitude ETC
By NICK/MUNRO ASSOC.
On 8.7.86



Vertical: 6dB/div with base of display at -82.0dB
0dB is located at 1 volt

Horizontal: 4000 microseconds or 1.37561 Meter to
264211 microseconds or 90.8628 Meter
scale: 2.4467E+01 Meter/inch or 9.6326E+00 Meter/cm.
71144 microseconds/inch or 28009 microseconds/cm.

Line Spacing: 652.158 microseconds or .224279 Meter
Line Width: 886.934 microseconds or .305019 Meter

Sweep rate: 19.73Hz/Sec

Sweep range: 9.64Hz to 201.31Hz

Window file name: A:HAMMING.W8T

Input configuration: Channel 1 Balanced
with 36dB of input gain & 9dB of IF gain.